UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

THE WELFARE IMPACT OF USAID-ADVANCE INTERVENTION PROGRAMME: EVIDENCE FROM ACDEP FACILITATION IN NORTHERN GHANA

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BY

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(M.PHIL. AGRICULTURAL ECONOMICS)

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THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS, FACULTY OF AGRIBUSINESS AND COMMUNICATION SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE (PhD) IN AGRICULTURAL ECONOMICS

APRIL, 2020

DECLARATION

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

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(Name of Student)	Signature	Date

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

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ABSTRACT

In response to the challenges of using traditional farming practices and in order to boost smallholder productivity on sustainable basis, many civil society organizations, NGOs and international donor agencies including USAID, under the auspices of its Agriculture Development and Value-Chain Enhancement (ADVANCE) project, has initiated many intervention programmes geared towards the development and dissemination of Good Agricultural Practices (GAPs). The study aimed at identifying the factors influencing participation in the USAID/ADVANCE value chain packages (GAPs and marketing strategies) and the impact on farm income and welfare of beneficiaries. The study used cross-sectional farm-level data collected from 673 farm households using a multiage sampling method from the three (former) northern regions of Ghana. It adopted the Multivariate Probit Model to analyze the factors influencing the adoption of the individual GAPs and marketing strategies as well as interdependency among them. The Poisson Data Count Regression was employed to identify the determinants of the intensity of adoption of GAPs. The propensity score matching (PSM) technique was used to estimate the welfare impacts of the ADVANCE intervention programme on the beneficiaries. The results indicate that farmers' educational level, age, visits to demonstration farms, and extension services, were found to have a positive and significant influence on different components of GAPs and marketing strategies. However, gender had a positive effect on the adoption of row planting but negative on cooperative marketing. The intensity of adoption was also positively and significantly influenced by educational attainment, farm size, ownership of tricycle, workshop attendance, visit to demonstration farms, and extension service; it was negatively and significantly affected by age of the respondent, number of household members in school, and engagement in off-farm income. The study has also demonstrated that the ADVANCE project has had a positive and significant impact on farm households' productivity, income and welfare. Finally, policies and development efforts focusing on increasing access to extension services, input and output markets are crucial to improving adoption of GAPs, and subsequently, to increasing farm productivity and welfare.

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DEDICATION

I dedicate this thesis to my wife Mavis Abena Nam and mother Mrs. Louise K. Avudzivi.

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LIST OF ABBREVIATIONS

ACDEP	Association of Church-Based Development NGOs
ACDI/VOCA	Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance
ADVANCE	Agricultural Development and Value Chain Enhancement Project
CRI	Crop Research Institute
FAO	Food and Agricultural Organisation
FtF	Feed the Future
GAFSP	Global Agriculture and Food Security Programme
GSS	Ghana Statistical Service
HLPE	High level Panel of Experts
IFAD	International Fund for Agricultural Development
ISSER	Institute of Statisitcal, Social and Economic Research
MDGs	Millinium Development Goals
NAAMSECOA	National Association of Mechanization Service Companies
NF	Nucleus Farmer
SNV	Netherlands Development Organization
SSA	Sub-Sahara Africa
UKAID	Department for International Development

UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
YIAP	Youth in Agriculture Programme

CONVERSIONS OF UNITS

Metric units	
1Kg	0.001T
1T	1000Kg
1ha	2.471acres
1acre	0.404Ha
1bag of rice	84Kg
1 bag of maize	100kg
1 bag of soybean	100kg

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The aim of every developing economy, particularly in Sub-Saharan Africa (SSA) is to reduce hunger and achieve food security even under the menace of climate change. Agriculture has remained the most important conduit for curbing hunger and achieving food security in Africa. Agriculture in SSA over the years has been spearheaded by smallholder farmers and their contribution cannot be over-emphasized. About 75% of the World's poor live in rural areas and depend directly or indirectly on smallholder farming for their livelihood (Africa Union, 2014). The numerous smallholder farmers (about half a billion) produce food that is consumed in urban centers, mostly in Africa and Asia (HLPE 2013, IFAD and UNEP 2013, FAO 2012). Thus, agriculture has been the largest employer in most developing economies. As a result, agriculture has been given the top-most priority in the international devevlopment agenda. For instance, a decade ago, in the wake of a serious crisis in the world food prices, world leaders through international donor organizations such as United States Agency for International Development (USAID), United Kingdom Aid (UKAID) and Netherlands Development Organisation (SNV) provided financial and technical assistance to some developing countries in their commitment to fight global hunger, food insecurity and poverty (Ahmed *et al*., 2016).

The main objective of these commitments is to reverse the decade-long decline in agricultural productivity. Some of the investments made in agriculture across SSA include farm water and soil management, and the provision of high quality inputs like seeds and fertilizers. In other countries, investments in agriculture have been focused on how farmers

can have easy access to both input and output markets, and processing of primary food products to boost the rural farm economy. Moreover, building the capacity of rural farm households regarding good agricultural practices (best practices) has also been one of the areas that have witnessed lots of investment in agriculture.

Undoubtly, the significant contribution of agriculture to the Ghanaian economy cannot be overemphasized. Agriculture is often considered as the engine of growth due to its significant contribution to the overall development of Ghana. It plays an important role through the provision of food and source of livelihoods for the populace and raw materials for the industries. Though the share of the agricultural sector to the Gross Domestic Product (GDP) has been dwindling over the years, it is still the pillar of the Ghanaian rural economy (Institute of Statistical Social and Economic Research [ISSER] 2017). The agricultural sector employs about 50% of the active labour force in Ghana (Ghana Statistical Service [GSS] 2015). The Ghana Statisitcal Service (2014) indicated that about 75% of the agricultural labour force live in the rural areas running small crop and livestock farms and about 22% of the labour force in agricultural and its related activities are found in the urban and peri-urban centers. The sector is generally small-scale with about 90% of farm families farming less than two hectares and producing about 80% of the agricultural output (Food and Agriculture Organization [FAO] 2015).

In Ghana, the main objective of agricultural development policies in recent times is modernization to achieve the goals of food security and economic development (MoFA, 2015). These programmes include improving access of smallholder farmers to improved productive technologies, mechanisation, irrigation, extension services, access to credit and agrochemicals, and marketing. Governments, civil organisations and donor agencies,

however, of late have been making a shift from these disparate strategies of agricultural modernization to an all-encompassing value chain approach. With a value chain approach, there are interlinked relationships among all actors starting from the acquisition and supply of inputs through production to processing until the final product is made available to consumers. Thus, the value chain development approach to food security and improved livelihoods is more sustainable.

A value chain can be defined as a set of actors (private, public, and including service providers) with the sequence of value addition activities involved in bringing a product from production to the final consumer (Miller and Jones, 2010). The Food and Agriculture Organization (FAO) (2010) defined value chain in agriculture as the set of actors and activities that bring a primary agricultural product from production in the field to final consumption, where at each stage, a value is added to the product. The agricultural value chain can also be thought of as "a farm to fork" set of processes and flows (Miller and Da Silva, 2007). It includes input dealers supplying inputs, farmers involved in the production and other actors involved in transportation, processing, storage and marketing at the various stages of the chain.

Though all the key players are critical in the value chain, this study will focus on farmers as the foundation of the chain. Empowering smallholder farmers to improve productivity is a necessary first step to achieving the optimum potential of the agricultural sector on a sustainable basis. One of the primary goals of many civil organisations and NGOs such as ACDEP and USAID-ADVANCE which implemented the ACDI/VOCA value chain project, was to assist farmers to achieve high productivity and quality products that meet market standards. Matthias and Muzira (2009) argued that for business to stay in the

market, their products and services need to continuosly meet changing market requirements and demands.

ADVANCE is an eight-year farmer-to-farmer project with two phases (2009 – 2013 and 2014- 2018) designed by ACDI/VOCA and funded by the USAID. ACDI/VOCA is an economic development organization based in Washinton, D.C. whose primary goal is to raise living standards through its work in agribusiness, food security, enterprise development, agricultural financing and community development (ACDI/VOCA, 2013). In Ghana, one key aspect of the ACDI/ VOCA project is to boost farm productivity and enhance farmers' access to local and international markets.

The project undertaken by ADVANCE/ACDEP focused on three major crops (maize, rice, and soybean) mostly cultivated in the three northern regions of Ghana due to their significant contribution to food insecurity, providing employment to the rural folks and combating poverty in the three northern regions of Ghana. According to the Ghana Poverty and Inequality Report by Cooke *et al.*, (2016) the three northern regions continue to have the highest poverty rates in the country, albeit they secured the greatest reduction in poverty between 2006 and 2013. However, the Upper East region achieved a considerable progress with their level of poverty dropping from about 73% in 2006 to about 44% in 2013, and Upper West region dropping from about 89% to about 71% in the same period. Surprisingly, poverty levels in the Northern region fell marginally from 56% in 2006 to about 50% in 2013. These poverty indicators are of grave concern in particular for the Northern region, where about 1.3 million people are living in poverty which is the largest number of people in any of Ghana's ten (former) regions (Cooke *et al*, 2016). The prevalence of poverty ranges between 44% and 71%, compared to about 34% and 28% in

the Brong-Ahafo and Volta regions, respectively, and about 6% to 21% in the five southern regions (Ashanti, Central, Eastern, Western and Greater). These figures indicate a dramatic north-south gap, with poverty as well as food insecurity remaining widespread in the three (former) northern regions (IFAD, 2012).

The causes of poverty and food insecurity in the north of Ghana are numerous and quite complex. These include; socioeconomic issues (poor education and health care), inadequate economic opportunities and poor infrastructural development. Moreover, environmental issues such as soil infertility and land degradation, harsh and erratic climatic conditions are other challenges that deprive inhabitants' livelihoods through a reduction in agricultural production. Many studies have concluded that one of the surest ways to bring northern Ghana out of poverty is through improved agricultural production – where the livelihoods of over 70% of inhabitants in the north depend on agriculture (Wood, 2013). Hence, there is an urgent call on the primary agricultural stakeholders to reverse this situation.

The primary objective of USAID-ADVANCE project facilitated by ACDEP is to enhance the productivity of the three main crops (rice, maize, and soybean) cultivated in northern Ghana through improvement in farmers' technical skills on GAPs and linkage to output markets. It is worthy to note that the Northern, Upper East, and Upper West regions have suitable climatic and ecological conditions which favour the production of these crops even though they have only one production season unlike southern Ghana where two production seasons exist in a year (i.e. main and minor seasons). With the heavy dependence of smallholder farmers on these crops for food security and livelihoods, these crops have

become strategic to the socio-economic development of rural farm households (which form the majority in the three regions) and northern Ghana as a whole.

1.2 Problem Statement

The sustainable development goals (SDGs) of zero hunger and no poverty is anchored on sustainable producton, increasing agricultural productivity, value additon in food systems and related activities, particularly within the crop sector. Transforming the agricultural sector is therefore critical in achieving the first two SDGs (Food and Agriculture Organisation [FAO], 2018). The Ghanaian agricultural crop subsector, however. comprises several crops; notably staple food crops such as maize, rice, sorghum as well as commercial cash crops such as cocoa, oil palm, pineapple, shea nut, cashew and mangoes. There are fruits and vegetables as well. Among these crops, the contribution of cereals to households' daily food consumption is significant. Undisputedly, a greater proportion of the Ghanaian meals contain cereals in one way or the other. Among all the cereals produced and consumed in Ghana, maize is considered the most significant followed by rice (Martey *et al., (*2012). Hence, the promotion and support for the production and related activities of these two crops are mostly funded by international donor agencies.

Rice has emerged to be the major staple food crop consumed all year round by both urban and rural dwellers. Perhaps as a result of the change in tastes and preferences of Ghanaian households, coupled with the ease of preparation of the crop. Rice cookeries have also become the main meal for hospitality industries, official functions, funerals and even traditional durbars. Asuming-Brempong *et al*. (2011) attributed the recent high demand for

rice to changing food preferences, speedy urbanization, high income levels and population growth. Despite the significant role of rice in the Ghanaian agricultural sector, its domestic supply is far in short of demand. This has been confirmed by MoFA (2014) that Ghana has achieved food sufficiency in all of its major staple foods with the exception of rice.

As a result, there have been lots of programmes from both government organizations (GOs) and NGOs to propel the production of rice. Some of the programmes include; Lowland Rice Development Project (LRDP), Ghana Commercialization of Rice Project (G-CORP), Inland Valley Rice Development Project (IVRDP), NERICA Rice Dissemination Project (NRDP), Food Security and Rice Producers Organization Project (FSRPOP) and Support to Ghana Rice Inter-Professional Body (SGRIPB). MoFA in collaboration with other institutions rolls out these programmes in many rice-producing areas in the country with the main aim of increasing yields, to help address the problem of poverty and food insecurity. Evidence from World Bank (2007), however suggests that how these resources and interventions are managed to ameliorate the plight of the poor may jeopardize their sustainability in food production in the long run. This has implications as to the implementation strategies, food security and welfare effects of the intervention programmes (Garnett and Godfray, 2012).

Maize remains the most significant staple food crop in Ghana and it is appreciated by all hence cultivated across the entire country. About 50% of the rural households cultivate maize while the proportion of the urban households engaged in the production of the crop is 16% (Quiñones and Diao, 2011). Despite the country's achievement of self-sufficiency in maize and recent increase in production, large yield gaps exist, particularly in the three (former) northern regions (MoFA, 2017; FAO 2015). Ghana's actual yield of maize

oscillate between 1.72 to 2.05 metric tonnes per hectare as against potential yield of about 5.5 metric tonnes per hectare (MoFA, 2017)[1]. The yield gap, according to Simtowe *et al*. (2016) could be attributed to partial or non-adoption of the full complement of the management practices that comes along with the intervention programmes.

In Ghana, the estimated demand of Soybean in 2017 was 600, 000 metric tonnes with production of 150,000 metric tonnes. This leaves a supply gap of 450,000 metric tonnes (Ghana Commodity Exchange [GCX, 2018]). The crop has largely been promoted by institutions such as Council for Scientific and Industrial Research (CSIR), MoFA and other international agencies such as ADVANCE. Currently, Northern region contributes about 70% of the cultivated land of soybean and about 77% of the national production (MoFA, 2017). The production of soybean is done mainly on a small-scale family-run farms of about 2 – 5 hectares with an average output per hectare (yield) of about 1.65 metric tonnes compared with achievable yield of about 3.00 metric tonnes (MoFA, 2017). The crop can be put to multiple uses such as source of biofuel, feed for livestock, nitrogen-fixing plant for other crops, and its oil and protein for human consumption. Many intervention programmes and projects in Northern Ghana such as Youth in Agriculture Programme (YIAP), Northern Rural Growth Programme (NRGP) and the Alliance for Green Revolution in Africa (AGRA) projects, are therefore promoting production and utilization of the crop through value chain enhancement. One of the key donor agencies that has attempted to use soybean value chain to boost the incomes of the rural farmers in northern Ghana is the USAID-ADVANCE project.

[1] This yield covers the period from 2013 – 2017.

Besides, the implementation challenges and percuiliar adoption issues associated wih intervention programmes, agricultural production in the three northern regions of Ghana face numerous challenges. These include inadequate access to extension services and market information, poor farm management practices, poor infrastructural development, and unsuitable climatic conditions. As a result, the increase in the production of these crops and many others have come as a result of an expansion in land under cultivation rather than an increase in productivity (MoFA, 2015). For instance, farmers in the rice, maize and soya sectors have producitivity gaps of 2.99mt/ha, 3.45mt/ha and 1.80mt/ha respectively to attain (MoFA, 2017). This suggests that any farm-level programme oriented to boost the levels of productivity will consequently raise the output, income and possibly the standard of living of farm households in northern Ghana. Over the years, there has been a great support of these developmental programmes, particularly in northern Ghana where they are mostly concentrated. Warsanga and Evans (2018) in assessing the welfare impact of wheat farmers participation in the value chain in Tanzania, however, have indicated that the impact of these intervention programmes have not been thouroughly explored.

Many civil society organisations (CSOs), NGOs and other international funding agencies have not relented but taken a keen interest in boosting productivity levels of these crops through the value chain development approach. ACDEP is one of the key NGOs that implemented the USAID-ADVANCE project, which is a value chain project seeking to improve the productivity of rice, maize and soya, thereby enhancing the well-being of the main actors. ACDEP operates in the Northern, Upper East and Upper West and parts of Brong Ahafo Regions of Ghana.

Key components of the value chain package have included capacity building in GAPs, and creating linkages among actors (farmers, input dealers, wholesalers/aggregators, transporters, financials institutions, procesors, etc.). Others include organizational development (OD) of the various segments of the chain (such as input dealers, processors, etc.) and value addition activities to enhance the quality of the produce/product. Some of the GAPs components that farmers were introduced to include the use of certified seeds, the conduct of germination tests, harrowing, row planting, and fertilizer application. The marketing strategies include grading, labelling, and collective marketing. Farmers are sensitized on the benefits of these practices or strategies and value addition techniques, and are stimulated to adopt them so as to improve their income and utimately their welfare.

Despite these massive investments in the three sectors, crop productivity is lower than expected and poverty is still pervasive in the three northern regions (MoFA, 2015; GSS, 2014). This situation raises significant issues regarding intervention efforts by governments, CSOs and NGOs, including that of ADVANCE/ACDEP, to increase agricultural productivity and the well-being of farmers. Several reasons may explain this kind of situation. One is the fact that there is partial adoption of programmes/activities by key actors in the value chain, leading to lower than optimum impact on their livelihoods (Diagne *et al.,* 2007; Dibba *et al.,* 2012; Baiyegunhi *et al.,* 2019). Other reasons are that differences in socio-economic factors (such as age, educational attainment, sex, etc.) and resource endowment (such as farm size, capital, labour, etc.) influence farmers' aspiration and ability to adopt new practices to change the status quo (Mmbando and Baiyegunhi 2016; Manda *et al*. 2015; Danso-Abbeam and Baiyegunhi, 2017). In assessing the socioeconomic factors affecting the adoption of conservation agriculture (CA) in Moroto

district, Uganda, for instance, Esabu and Ngwenya (2019) indicated that both young and old people had adopted CA primarily as result of the ability of young people to access information readily and the old relying on their experience of profitability in agriculture. A similar finding had been made by Giller *et al.,* (2009). The same study also revealed higher education as having negative influence on adoption of conservation practices. This was as a result of higher education been associated with increased specialization making CA less attractive. This finding is in line with that of Matata *et al.,* (2010) who observed that if farmer could read and write, they would be able to follow technical recommendations. In a related paper, 'understanding gender dimensions of agriculture and climate change in smallholder farming communities in Ghana and Kenya,' Jost *et al.*, (2015) noted that women are less adaptive to climate change practices because they are more resource constraints than their male counterparts. Besides, the strategies being adopted create high labour loads for women with males having the upper hand over the control of resources and access to extension services.

Though evaluation of projects/programmes is often undertaken at the end of these intervention programmes by the implementing entities, it is often focused on the timeliness and release of resources or budget allocations rather than on the welfare of the beneficiaries. This study, therefore, intends to fill this void by documenting farmers' adoption of the farm packages introduced to them using ADVANCE as a case study. Even though Abdul-Rahman and Donkoh (2016) carried out some research on the ACDEP value chain development programme in the Northern Region, the study failed to consider the impacts of ADVANCE intervention programmes on the welfare of the farmers. Hence, this study intends to fill these gaps and contribute to the existing knowledge on intervention

programmes in Northern Ghana by estimating the welfare impact of USAID-ADVANCE value chain development programme. An understanding of the USAID-ADVANCE value chain programme and its impacts on farmers' welfare could help in the design of future programmes targeted at improving livelihoods through farm productivity.

From the above premise, the following research questions become critical.

1. What is the nature of adoption situation of the USAID-ADVANCE value chain package?
2. What are the factors influencing farmers' participation in the USAID-ADVANCE programme?
3. What are the factors influencing the adoption of the farm management and marketing practices by the farmers?
4. What are the determinants of intensity of adoption of agricultural practices and market access programmes by the farmers?
5. What is the effect of the participation in the USAID/ADVANCE programme on the welfare of the farmers?

1.3 Objective of the Study

The aim of this study is to identify the factors influencing the adoption of the USAID/ADVANCE value chain packages and their impact on welfare of beneficiaries.

The specific objectives are to:

1. Document the nature of adoption of the ADVANCE value chain package;
2. Examine the determinants of participation in the ADVANCE intervention programme;

3. Identify factors influencing the adoption of the selected farm management and marketing practices;
4. Investigate the determinants of intensity of adoption of Good Agricultural practices and market access programmes;
5. Estimate the effect of the ADVANCE intervention programme on the welfare of beneficiaries; and

1.4 Hypotheses of the Study

A hypothesis is a tentative statement that depicts the relationship between two or more variables. The following hypotheses were tested in this study:

1. H_0: Farmers' demographic characteristics, farm-specific and institutional factors do not influence the productivity and market access hence income of the farmers.

   H_1: Farmers' demographic characteristics, farm-specific and institutional factors influence the productivity and market access hence income of farmers.

2. H_0: Farmers' demographic characteristics, farm-specific and institutional factors have no significant effect on the intensity of adoption of agricultural management practices and market access.

   H_1: Farmers' demographic characteristics, farm -specific and institutional factors have significant effect on intensity of adoption of GAPs and marketing access practices

3. H_0: The ADVANCE intervention programme has no causal effect on the welfare of the beneficiaries.

   H_1: The ADVANCE intervention programme have significant effect on the welfare of beneficiaries

1.5 Significance of the study

This study seeks to provide a comprehensive information on the impacts of interventions on the welfare of the treated households using ADVANCE intervention programme as a case study. The study is relevant in the areas of scientific contribution, farm-level policy design and implementation, and agricultural extension delivery and advocacy.

There are many intervention programmes being rolled out by local and international NGOs in Ghana, particularly in the three (former) northern regions. The main objective of these programmes is to help boost the productivity of farmers through provision of knowledge and skills required to efficiently manage their farms and sell their products to the market. It is therefore expected that building the capacity of farm households through agricultural training programmes should boost rural farm income and subsequently improve their welfare. The government of Ghana for instance is currently implementing PFJ programme aimed at achieving self-sufficiency in rice production, maintain self-sufficiency in maize production and increase the production of soybean for the purposes of food and nutritional security. Besides, the recently launched Rearing for Food and Jobs (RFJ) and Planting for Exports and Rural Development (PERD) are geared towards increasing livestock production to meet the high demand for meat, reduce importation and as well as create a sustainable raw material base for industries and increase the country's revenue in exporting

agricultural products. To achieve these, policy makers need guidance on some of the factors that explain farmers' participation in such intervention programmes as well as the quantitative impacts of such programmes. As sated earlier, Abdul-Rahman and Donkoh (2016) assessed a value chain intervention programme in northern Ghana but they only analyzed the determinants of participation in the ACDEP VC programme without delving into the welfare impact of the programme, Moreso they did not look at the ADVACE value chain programme. Although many intervention programmes have been implemented by agencies, there is dearth of empirical evidence on the impact of such programmes on the welfare of farm households who participated in such programmes using econometric techniques. This study, therefore, attempts to bridge this void by providing empirical evidence on the impact of ADVANCE intervention programme using a more rigorous impact evaluation tool as opposed to the purely descriptive approach of measuring impact of intervention programmes employed by NGOs and other studies. Besides, Mmbando *et al*. (2015) assessed the welfare impact of smallholder farmers' participation in maize and pigeaon market in Tanzania using propensity score matching methods, the study focused solely on market participation as a unit while this study will take into consideration the different components (labelling, grading and collective marketing) of market participation. An impact evaluation of the Millennium Development Authority (MiDA) FBO trainings also showed an improvement in the use of citified seeds and fertilizer application by smallholder farmers but this was mainly driven by starter packs (ISSER, 2012). This study moves a step ahead to find out the effect of trainings on adoption of farm management and marketing access practices by smallholder farmers in the absence of starter packs.

Moreover, given the scale of investment from the funding agency, USAID, the value for money with respect to its impact on rural farm households becomes a big policy question. Many studies had focused on the impact of improved agricultural technologies such as new variety of seeds, adoption of fertilizer, among others. The unique feature of this study is that, it considers the bulk component of the programme that encompasses both farm management practices and market access strategies. This will provide a comprehensive assessment of the programme impact on productivity and farm income that together translate into welfare.

Also, the findings of in this research will assist extension officers as they will be aware of some of the factors shaping the participation as well as the adoption and intensity of adoption of farm management practices and market access strategies as this has not been adequately dealt with by some researchers. Donkoh and Awuni (2011) for instance evaluated an intervention programme that focuses on adoption of farm management practices in lowland rice production in northern Ghana without assessing the marketing components. Finally, the findings of the study will add to the existing literature on impact evaluation in the Ghanaian agricultural sector.

CHAPTER TWO

2.0 THE OBJECTIVES, COMMODITY CHARACTERISATION AND STRATEGIES OF ADVANCE PROJECT

2.1 Introduction

This chapter reviews literature on objectives of the ADVANCE project and strategies earmarked towards the attainment of these objectives. The three broad strategies of enhancing the competiveness of the value chains, increasing market access through development of local and regional markets as well as financial inclusion have been elaborated upon. The chapter also details out the general framework of nucleus-farmer outgrower scheme deployed to reach out to large numbers of smallholder farmers. The nucleus-farmer outgrower distinguishes the ADVANCE project from similar ones in reaching out to their target clients. This is followed by presentation on the current situation as well as the constraints and competiveness of the three value chains namely maize, rice and soybean.

2.2 Objectives and Strategies

USAID awarded the ADVANCE project in July, 2009 to ACDI/VOCA through the Feed the Future (FtF) Leader with Associate (LWA) mechanism under the Cooperative Agreement No. 641-A-00-09-00026-00. The cardinal goal of the project is to facilitate the transformation of the country's Agricultural sector through specific commodities/industries in order to achieve increased competiveness in all market segments – domestic, regional and international. According to the ADVANCE first year implementation annual report (2010) (October, 2009 – September, 2010), the project was

carved out to contribute directly to USAID's strategic Objective 6 "Increase competiveness of Ghana's Agricultural sector in domestic, regional and international markets" as well as the outcomes of the Global Food Security Response (GFSR) programme targeted at increasing growth, food security and stability in the agricultural sector. As much as this strategic objective of USAID might be sound, it may not be the game changer for the transformation of Ghana's agricultural sector. A review of the country's agricultural investment plan indicates that, it is not focused enough to channel incoming projects/donors or investments to prioritized areas that are more likely to trigger the needed transformation of the agricultural sector (FAO, 2012). Donors therefore carve out their own objectives and dictate areas of investment in the agriculture sector that are less likely to significantly impact the sector. Nonetheless, the ADVANCE project, adopted a value chain approach where farmers were linked to inputs, markets, equipment, finance and information through larger traders and aggregators and commercial farmers referred to as nucleus farmers. These aggregators and commercial farmers were selected based on indicated criteria that they have the potential and will invest into their respective value chains. Smallholder farmers are subsequently expected to increase the efficiency of their farm business with improved production and post-harvest handling practices. These practices revolve around three key components:

- Enhanced Value Chain Competiveness;
- Increased Market Access and Development of Local and Regional Markets; and
- Increased Access to Financial Services.

These broad areas, according to the ADVANCE First Year Implementation Plan, have an integrated module and activities targeted at achieving the overall goal of transforming Ghana's Agricultural sector.

2.3 Enhanced Value Chain Competiveness

The first component, "Enhanced Value Chain Competiveness" involves improving upon the productivity of the selected commodities beginning from the point of input supply through improved productivity of the crop on the field to ensuring product quality along the value chains. This would be achieved through facilitation and establishment of efficient relationships and linkages between and among the principal actors – farmers, input dealers, aggregators etc., and auxiliary actors – financial service providers, transporters, extensionists etc. along the value chains. While the current achievable yields per hectare for rice, maize and soybean is 6 metric tonnes, 5.5 metric tonnes and 3.5metric tonnes, current yields are 3.01 mt/ha, 2.05mt/ha and 1.7mt/ha (MoFA, 2017). It must, however, be noted that, the existence of efficient relationships and linkages among actors in a value chain does not necessarily lend itself to good value chain governance and increased productivity. It is essential for equity to prevail within a value chain, if indeed a particular VC will be sustained or will stand the test of time. The equity distribution along the value chain must be a purposeful human activity using the resources in the society and the environment either individually or collectively to achieve this identified purpose of equity. ADVANCE's strategies of ensuring competiveness of the value chain focused on:

(a) development of quality seeds (certified seeds) for use by farmers;

(b) encouraging and supporting use of simple mechanization services by all actors along the commodity value chains;

(c) enhancing input access by farmers; and

(d) increased access to agri-finance and development of warehouse receipt system for grain storage.

2.3.1 Use of certified seeds and demonstration plots

Quality and certified seeds are crucial for any significant improvements in yield of crops, and the lack of expertise in the production of improved seeds has led to limited quantity of seeds for distribution and dissemination to farmers. According to the ADVANCE annual report (2010), the project in consultations with the country's regulatory services such as the Plant Protection and Regulatory Services Directorate (PPRSD) of MoFA, Crop Research Institute (CRI), Savannah Agricultural Research Institute (SARI) and selected aggregators and industrial buyers of maize agreed to import high yielding hybrid seed varieties from Pioneer and Pannar seed companies for adaptive trials at specific locations in the country. The performance of the seeds was evaluated by the CRI of Ghana. Demonstration plots were subsequently organized with nucleus farmers as the fulcrum for reaching out to smallholder farmers. Tailor-made trainings in the production of quality and certified seeds, performance of germination tests, row planting, weed control and fertilizer application were organized for some seed growers to take up the production of the seeds and showcase quality seeds through demonstration plots. Private sector-input dealers and nucleus farmers were also part of the demonstration activities. There was, however, an uncertainty as to whether the trained seed growers were well equipped to import hybrid seeds on their own for multiplication and distribution to farmers, hence the call for the

promotion of local indigenous varieties that are not likely to get extinct seems to resonate well with some crop breeders and other stakeholders in the country.

2.3.2 Mechanized Services

On enhanced access to mechanized services, the strategy was to support the National Association of Mechanization Service Companies (NAAMSECOA) with technical staff to draw business plans for submission to financial institutions (e.g. Stanbic Bank to finance acquisition of farm machinery, including but not limited to planters, harvesters, tractors, threshers, and spare parts as recommended by the technical team). The sustainability of this aspect of the service delivery hinges on strong linkages between the private sector/companies (NAAMSECOA) and financial institutions. The equipment suppliers provided after-sale services to all customers leveraged by the ADVANCE project, while aggregators stood surety to farmers for service delivery by NAAMSECOA to farmers for the latter to pay at the end of the cropping season. As laudable as the ADVANCE initiative might be, the mechanization arena should have been properly organized as a business entity on its own with full complement of farm machinery supplying varied services such as seeding, threshing, harvesting, drying etc. to smallholder farmers.

2.3.3 Supply of Agrochemicals

As critical as the input arena is to the attainment of agricultural transformation, the input industry in Ghana is weak and more defined by trade relations as opposed to effective management of distribution networks (ADVANCE Annual Report, 2010). This has made the input supply firms to be unresponsive to the largest segment of the smallholder market. ADVANCE strategy was to focus on industry level changes through targeted interventions with input firms and service delivery providers so as to meet market needs and expectations

effectively. This requires changes in their promotional and distribution modalities which entails:

- Training of input suppliers on the fundamentals of retailing and other expansionary routes;
- Development and policing the enforcement of agreements with input companies to support retailers to grow and improve their market position with the ever-increasing number of smallholders;
- Use of radio as a credible source of solution provider of agricultural related challenges and means of enhancing their presence in communities;
- Application of SMS technology to enhance customer relations and inventory organisation and management;
- Explore the use of texting service links to offer spraying services;
- Interrogate the use of "Village Agent" models to increase distribution networks and community presence; and
- Training on protection, safety and environmental management practices.

The input arena is another specialized area that could have been organized as business unit on its own (input supply, spraying services, etc.) with auxiliary services instead of being an association or individuals linked to farmers to provide services. An input business entity would own other assets e.g. spraying machines, and offer additional services to farmers for a fee. This appears to be a more sustainable way of providing inputs and its related services to smallholder farmers.

2.3.4 Outreach Strategy

The goal of the outreach unit under ADVANCE is to create visibility for the project and promote the flow of information to all actors along the value chains. The modus operandi of the unit is to design and implement interventions aimed at enhancing the effectiveness of information flow to actors along the commodity value chains. The unit thus seeks to process and improve information content to targeted actors (input dealers, farmers, retailers, aggregators/brokers, processors, transporters etc.) along the value chains to ensure that every actor gets the requisite information for upgrading. To this end, community and regional radio stations and use of SMS as an information exchange platform were deployed to reach out to commercially viable agri-enterprises in rural communities. Radio stations were subsequently linked to one another to form network of stations together with sponsors and expert guest panelists. Input companies were equally facilitated to make use of festivals as platforms to promote, create visibility, market and sell their products to the general public. Booths/stands were created at these events to achieve the aforementioned objectives. In order to collaborate with the appropriate radio stations, listenership surveys were conducted to determine which radio stations farmers were listening to for agricultural information.

2.3.5 Geographic Information Systems (GIS)

GIS was deployed as one of the strategies to gather relevant agricultural data on producers in terms of production levels, number of acres, accessibility, spacing regime, productive age, production forecast, crop variety and plant population under cultivation to pave way for planning purposes and to tackle challenges confronting actors along the value chains. The GIS was also leveraged upon to coordinate and introduce aggregators and processors

to locations of commodities to be sourced as well as facilitate research into diseases, and pest control. This technology was also used to aid the distribution of planting materials.

2.4 Increased market access and development of local and regional markets

The viability of commercial agriculture and its sustainability require efficient and deregulated markets. Thus, markets and improved market access play an important role in improving rural incomes of small-scale farmers in developing economies, particularly in SSA (Ouma *et al*., 2010). ADVANCE employed a number of strategies to enhance market access for their clients. Firstly, assessment on key aggregators and processors were undertaken to ascertain their technical, management and/or financial capabilities and parameters in meeting specifications and standards of competitive markets of the selected commodities (ADVANCE Annual Report, 2010). Thereafter, appropriate and commensurate interventions were recommended and executed to solve the challenges identified during the assessment. For instance, processors requiring technical assistance were assigned volunteers of specific skills set to provide the needed service as a remedial measure for stipulated period of time.

The medium to long term solutions put in place was the training of staff of the targeted actors to take up the activities upon departure of the volunteer expert. Tailor-made training sessions/workshops were also organized for a select group of actors with similar technical challenges at appropriate times. The grant component of the ADVANCE project was also leveraged upon by some processors to secure loans for equipment upgrade to meet market standards and requirements. This strategy of the project is commendable as limitations of processors in developing countries, particularly Ghana, mostly hinge on inadequate and

inappropriate technology to process to meet global market standards. To ensure that processors get steady supply of raw materials and to avoid side selling by farmers, contracts were written and signed between processors and producers. Agreements were signed between producers and processors irrespective of locations of the actors – agreements were signed between rice farmers in the Upper East and processors in the Eastern region of Ghana. Another notable strategy employed by the ADVANCE team in enhancing market access and development of local and regional markets is collection, analysis and presentation of weekly prices of the targeted commodities on monthly basis to serve as a guide for farmers, buyers as well as value chain actors and implementers in advising their clients. Esoko, a local company was partnered with to execute components of the publication of commodity prices to farmers.

2.5 Financial Services

Hussain & Malik (2011) stated that credit availability to farmers is much more crucial to smallholder farmers than any other factor required to enhance the resource use efficiency in the agricultural sector. ADVANCE's strategy in increasing the volume of credit to the agribusiness sector was to identify and minimize opportunities of credit risk in the sector, create enabling environment and comfort zone for banks to invest in the sector (ADVANCE Annual report, 2010). This is followed by earmarking interested and committed financial institutions and building sustainable linkages between them and promising players in the agribusiness sector. MOUs were signed between ADVANCE and ARB Apex Bank as an anchor financial institution to build the capacity of rural banks on how to effectively deliver financial services to the agribusinesses sector. Another

innovative strategy was the development of a model aimed at buying down the risks in the sector through regular monitoring of loan portfolios on the field that was well-coordinated with key milestones set up towards full repayments. This entails activities starting from the input selection stage to the delivery of inputs and services; crop management; harvesting and post-harvest management; transport; processing and payments, among others.

Since most banks do not usually want to take up the responsibility of visiting farms to monitor loans, volunteer interns were deployed on pilot basis to carry out this activity. Lessons learnt were shared with the banks to serve as guide in deploying permanent staff to execute the task. It is, however, difficult to confirm whether Banks indeed employed permanent staff to continue with this model after the pilot project. Next strategy was the sensitization of actors to open accounts and transact business with the banks as the first necessary step to make them eligible to access credit. ADVANCE encouraged honesty, transparency and trust between and among outgrowers and nucleus farmers/aggregators that led to the strengthening of business relationships and subsequent granting of production input support and loans by nucleus farmers and aggregators to smallholder outgrower farmers.

Even as financial institutions continue to experience high loan default rates it is refreshing to note that ADVANCE Report (2010) indicated the innovativeness of aggregators/money lenders in the informal sector's ability to pre-finance agribusiness and recover loans, albeit little education. This model as adopted in the informal sector must be researched and upscaled as one of the strategies in transforming agricultural financing.

In line with the principles of project management and constant review of on-going projects, ADVANCE realized the need to introduce village loans and savings scheme (VSLA) to

their beneficiaries which was welcome and executed by smallholder farmers. This scheme (VSLA) is one of the many footprints left behind by the project.

As indicated at the earlier part of this chapter, ADVANCE strategy, the three key components of *enhanced value chain competiveness, increased market access* and *enhanced access to financial services* were to be achieved through targeted aggregators and commercial/nucleus farmers capable of investing into the chain. The motive of *nucleus farmer-outgrower scheme* was to reached out to a larger number of smallholder farmers. The workings of nucleus-outgrower scheme is our next topic for discussion.

2.6 Nucleus Farmer-Outgrower Scheme

The nucleus farmer-outgrower or nucleus-farmer scheme is a framework adopted by ADVANCE in implementing an all-inclusive value chain project aimed at reaching out to a larger number of smallholder farmers and as a means of leveraging on these farmers to achieve rapid transformation of Ghana's agricultural sector. A nucleus farmer (NF) under the ADVANCE project is a registered farmer/business entity in selected commodities in the agricultural sector that has certain basic resources and a sizeable number of smallholder farmers - out growers (25-6000). Although participation in the programme is voluntary and by self-selection, both parties work together for mutual benefits with the NF, the stronger partner in the relationship, pre-financing his out growers with inputs such as seeds, fertilizers, herbicides on credit in varying quantities as they can afford. The NFs also provide mechanization services (ploughing, threshing), transportation, training on best agronomic practices, market information (standards and specifications, farm gate price)

etc. The costs of inputs are computed and paid back in form of produce to the nucleus farmer who also doubles as a ready market outlet for the producers.

The NF-Out grower relationship enables out growers enjoy a somewhat formal relationship with the larger aggregators and exporting/ processing farms as a result of the formal contract between the nucleus farmer and their end buyers which is an obvious way of enhancing market access for smallholder farmers. The Nucleus farmer could also guarantee loans from banks for the out growers. The out growers do not receive the loans in cash but are given vouchers from the bank with which they purchase the inputs from the input suppliers. The bank accounts of the out growers are then debited with the cost of the inputs.

Although the NFs and outgrowers as indicated above have certain basic criteria for proper functioning of the relationship, their participation in the intervention programme is voluntary and by self-selection. Thus, both categories of a NF or outgrower decide on their own whether to participate in the programme or not and same opportunity were extended to the non-participants as well.

2.7 Current Situation of Maize Value Chain in Ghana

Maize is a versatile crop that can be grown across varied ecological zones in Ghana. The FAO (2012) stressed that maize is produced at every part of Ghana with leading producers concentrated in the middle southern part ranging from Eastern, through Ashanti to the Brong Ahafo region. According to the technical report (MAFAP), by Food and Agricultural Organization, 84 percent of the maize commodity is produced at the middle belt with the remaining 16 percent in the Upper East, Upper West and Northern regions.

West Akim district in the Eastern Region has been noted as the highest productivity district in terms of yield performance (MoFA, 2017) and Sissala West in the Upper West region as the lowest productivity district among the top ten districts in the country between 2014-2016 as shown in Figure 2.1.

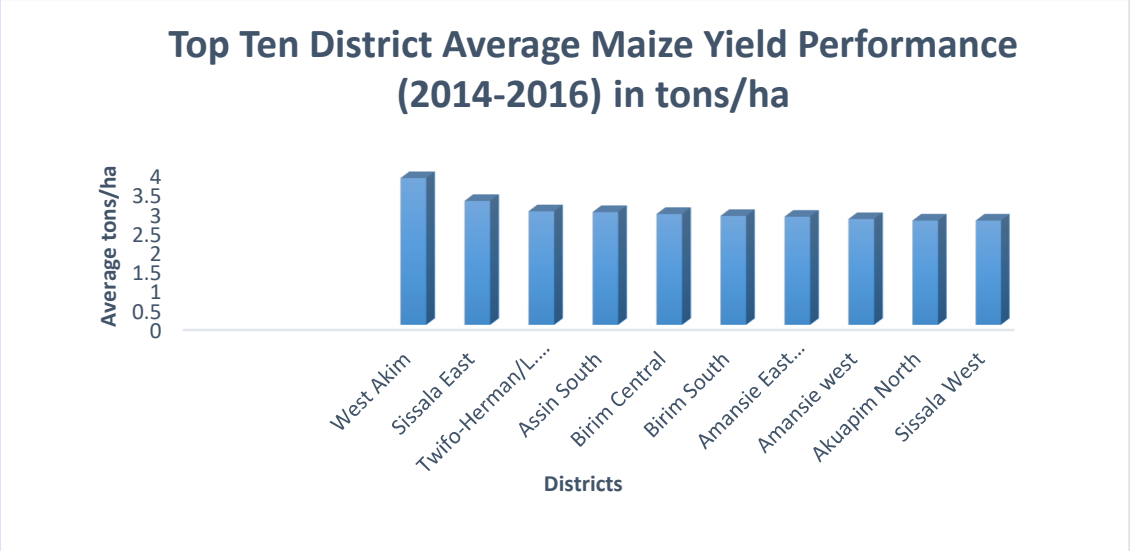

Figure 2.1: Top Ten District Average Maize Yield Performance (2014- 2016)

The national average yield has been 2.05mt/ha with an achievable yield of 5.50 implying the country has been able to achieve only 37.27 percent of its achievable yield.

With respect to trend in production of the commodity, a critical analysis shows a relatively stable quantity from 2013 to 2017 with 2017 cropping season recording an increase of 15.3%. The high dependency on rainfall and reliance of smallholders on traditional methods of producing sizeable portion of the commodity might account for the stable production levels. The 15.3% increase in 2017 can be attributed to the improvement in the productivity from 1.99mt/ha to 2.05mt/ha (percentage increase of 3%) perhaps as a result of government's programme, PFJ and favourable rainfall pattern over the period as there

was only 12.1% increase in area cultivated from 2016- 2017 (MoFA, 2017) (Refer: Figure 2.2).

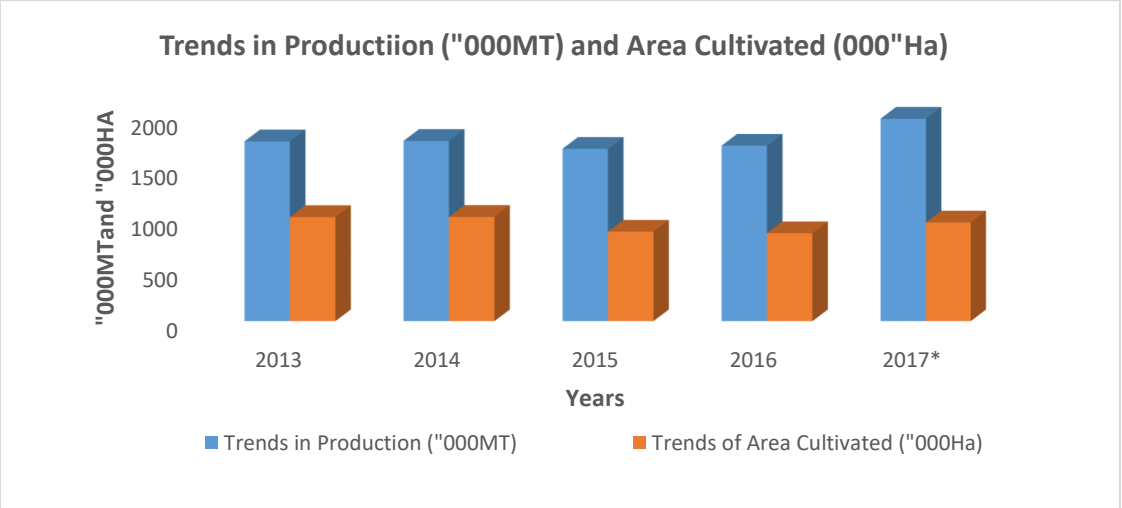

Figure 2.2: Trends in maize production and area cultivated
Source: Statistics, Research and Info. Directorate (SRID), Min. of Food & Agric (2017)

Though the production of maize is across all ecological zones in the country, certain areas are noted for the marketing and trading of the commodity. The Techiman market in the Brong Ahafo region (former) for instance is key "feeder" market for maize to Accra and Kumasi to the southern part of the country and Bolgatanga to the north thence to Burkina Faso and/or Cote D'Ivoire. Other notable markets in the Brong Ahafo region are Dormaa maize market, Badu maize market and Odumase maize market. The concentration of these markets in the Brong Ahafo region might largely be due to the large volumes of the commodity produced in the region. These markets are dominated by market "queens" or women who assemble the commodity from the local areas/districts to market centers for wholesalers or bigger aggregators who engage in spatial arbitrage across districts/regions. Other important maize markets are the Tamale market in the northern region, Kumasi

Central and Ejura market in the Ashanti Region, and Maame Krobo maize market in the Eastern region. These areas also serve as high production zones in the country. Agbogbloshie market in the Greater Accra region is a hub for maize for most consumers in Greater Accra and southern part of the country in general.

2.7.1 Constraints and Competitiveness of the Maize Value Chain

Despite the enormous potential of the maize value chain in reducing poverty, the full benefits of the commodity remain largely untapped due to a number of constraints affecting its production and productivity. An important factor affecting productivity of the crop is inadequate certified seeds, accounting for most planted maize being uncertified (Asiedu, *et al.,* 2007; Ba, 2017). Farmers complained about the high cost of hybrid and certified seeds. Subsequent to the high cost of seeds is the exorbitant cost of fertilizer, resulting in its low application to crops on farms. Insufficient access to different farm machinery for varied activities on the field limits potentials of seeds, hence, not achieving its achievable yield. Besides ploughing, which is common in the three northern regions, farmers hardly deploy any other mechanized activity during the production process. Thus seeding, weeding, harvesting etc. are manually carried out with a lot of drudgery, effort and time (MoFA, 2017). According to a study conducted by MoFA in 2005, only about 40% of farmers in Ghana apply some form of mechanization during their farm operations. Other notable constraints that have been documented in the literature are high interest rates on loans to the agriculture sector, non-conformance to commodity standards, limited extension services, hence poor knowledge of farmers in improved agronomic and management practices, harsh climatic conditions for rainfed agriculture, coupled with poor

and disjointed infrastructure in most production areas (Asiedu, *et al.,* 2007 and Wood, 2013).

Overcoming some of the challenges enumerated above would boost the productivity of maize which is currently pegged at 2.05mt/ha as against achievable yield of 5.50mt/ha (MoFA, 2017). This implies that only 37.27% of the potential has been achieved. Ba (2017) confirmed the low productivity and competiveness of the Ghanaian maize value chain by indicating that maize yield in the country is approximately two thirds lower than the global average of 5.1 tons per hectare, and usually lower than the African average yield of 2.1 tons per hectare. This obviously makes the Ghanaian smallholder less competitive compared to his colleagues elsewhere. Similarly, the high cost of production largely attributable to cost of fertilizer affects the Ghanaian smallholder adversely. According to Ba (2017), the total cost of production per hectare in Ghana in 2014 was Gh¢ 1,835 with an average yield of 2.283 kg/ha and price range of Gh¢ 0.40- 0.80 per kg. Investment into the production of maize was therefore considered as an unprofitable venture. In fact, a loss of Gh¢ 465 was incurred, according to Ba's (2017) study. Notwithstanding, Ragasa, Chapoto, and Kolavalli (2014), estimated the gross margins of maize production by small to medium scale producers across different ecological zones of Ghana under different combinations of fertilizers and seeds and arrived at a marginally positive figures. The inclusion of cost of family labour into the computations, however, yielded a negative gross margin values under almost all conditions.

Another impediment to competiveness of the maize value chain is the huge losses made during post-harvest activities. According to Bruno (2016), Ghana loses about 18% of its total annual output of maize as result of practices of farmers, warehouse attendants and

transporters along the value chain. Interestingly, the (former) three northern regions account for 10.7% of the loses with Brong Ahafo, and Central Region recording the least with 0.2% and 0.1% respectively.

Akramov and Malek (2012) cited in Abdulai *et al.* (2013) stated that maize is a key staple food crop in Ghana and constitutes more than 50% of cereals produced in the country across all agro-ecological zones. The bulk of the maize commodity is used for human consumption (Gage *et al*., 2012) and it is the most important food security crop while the rest is used as feed for poultry. Whilst the per capita consumption of maize increased at an average rate of 2.8% from 40.3kg to 45.0kg in 2015, the demand for maize as feed for the poultry industry increased at an average rate of 10% per annum over a ten-year period of 2000-2009 (Ragasa, *et al.*, 2014).

The Ghanaian maize value chain has great prospects of being competitive, considering the favourable climatic conditions across the agro-ecological zones. This is supported by the bimodal rainfall pattern in southern Ghana that allows for two growing seasons for the crop and unimodal rainfall season in northern Ghana that permits one growing season. Contemporary governments have also targeted the agricultural sector as the engine of growth of the domestic economy by deliberately making efforts at minimizing the cost of production by subsidizing critical inputs in the sector. Prices for fertilizer and maize seeds have been subsidized by 50% for all farmers under the PFJ Programme. A study by Ragasa *et al.* (2014) have confirmed the lower prices of hybrid seeds in Ghana compared to other countries. Subsidies on seeds have the potential of increasing the acreage under improved/certified seeds, as only about 15% of total maize area has been planted with certified/improved seeds (Ragasa, et al., 2014). Another study by Chapoto and Ragasa

(2013) has affirmed that plots planted with certified seeds and appropriate quantities of fertilizer have recorded higher yields of approximately 330kg/ha than farms planted with uncertified seeds.

2.8 Current Situation of Soybean Value Chain in Ghana

Unlike most grains that are cultivated extensively across all ecological zones, soybean thrives very well in Guinea Savanna and Transitional agro-ecological zones of Ghana. It is therefore mainly produced in the three (former) northern regions of Ghana (Northern, Upper East and Upper West), parts of Brong Ahafo and northern Volta. The leading producers can be located within and around Kpandai, Gonja East and Nanumba districts, Yendi, Bawku and its environs and Garu. Supporting districts in terms of production can also be found in Upper West region notably, Sissala East and West districts and the three districts around Wa (Wa East, Wa West and Wa Municipal). The national Soybean productivity as at 2016 was estimated to be 1.5mt/ha with Northern region leading with productivity of 1.68mt/ha followed by Upper West 1.36mt/ha, Upper East and northern Volta recording 1.05mt/ha and 0.81mt/ha respectively as against achievable yield of 3.5mt/ha. The Statistics, Research and Information Directorate of MoFA in 2016 indicated the supply gap of soybean to be 447,000mt (MoFA, 2017). This gap is often filled by private participants through importation of both raw soybean and soymeal from U.S., Brazil and Argentina and it is an opportunity for domestic production to be stepped up to take advantage of the existing market. Figure 2.3 shows the regional distribution of the commodity over a six-year period with Northern region as the leading producer. From geographical perspective, the production of the soybean can be grouped into two categories

though with the same season of production. Thus, the northern belt produces 98% of total output while production from the southern belt accounts for only 2%.

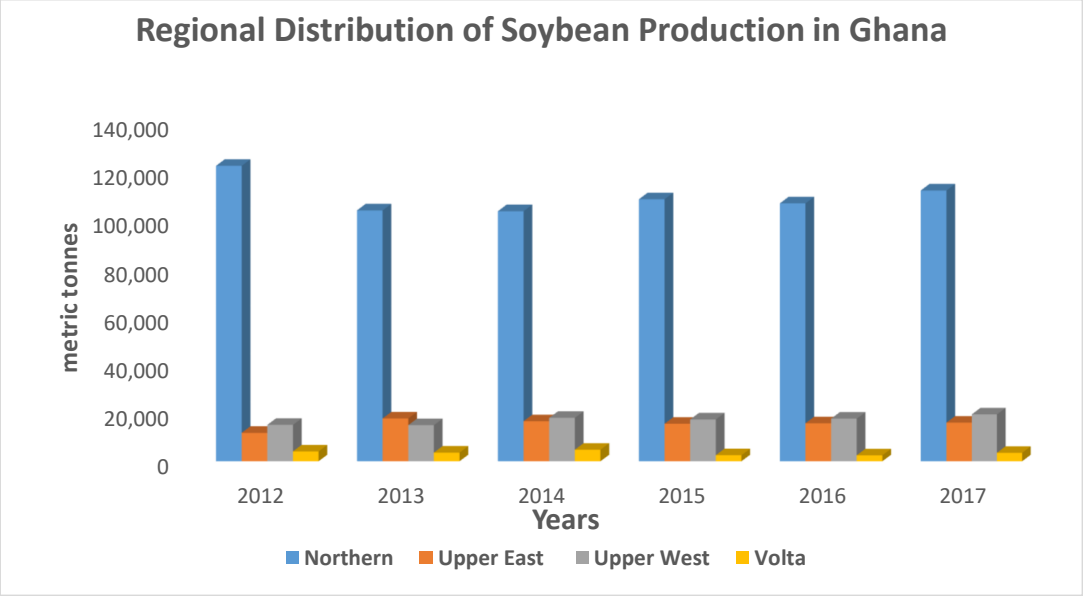

Figure 2.3: Regional distribution of Soybean Production in Ghana (MT)
Source: Statistics, Research and Info. Directorate (SRID), Min. of Food & Agric (2017)

Whilst the northern belt has specialized in the production of the crop, the middle and southern belts have been noted for trading, processing and consumption of the commodity with processors concentrated in Brong Ahafo (Techiman and Sunyani), Ashanti (Kumasi) and Greater Accra regions and consumption (poultry farmers) centres located in Ashanti and Greater Accra (Fig 2.4).

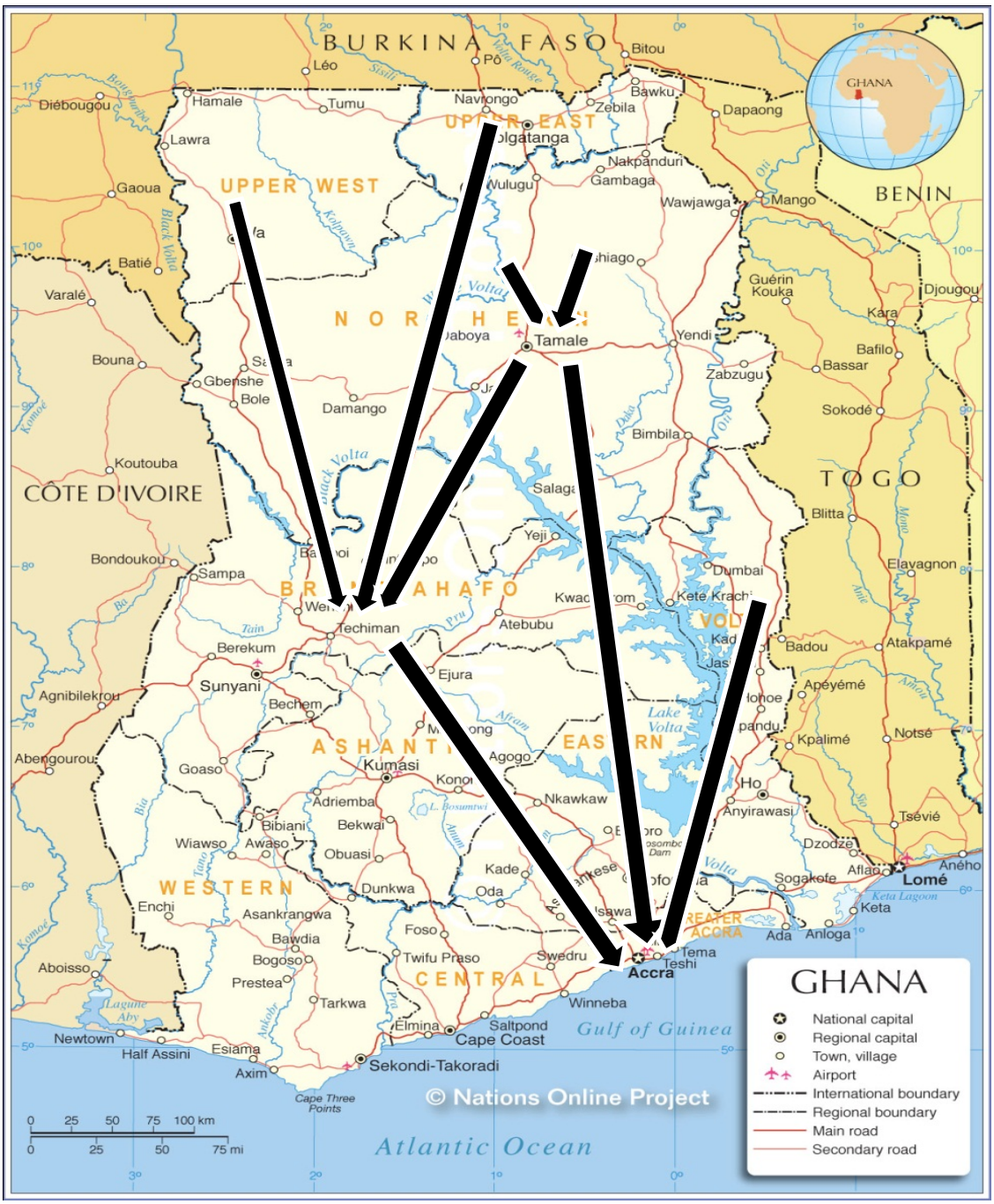

Figure 2.4: Soybean production, trading, processing and consumption map

Source: The Soybean Value Chain per the GCX model, November, 2018

2.8.1 Constraints and Competitiveness of the Soya Value Chain

Similar to any other crop, the adoption of improved varieties of soybean has been low among smallholder farmers (Audu & Aye, 2014) but the most commonly grown among Ghanaian farmers is the non-shattering variety *Jenguma*. The recommended fertilizer for Soybean is triple-superphosphate (TSP) which is scarce and more expensive than formulated NPK fertilizer for maize. Farmers therefore, apply this inappropriate and relatively cheap fertilizer (NPK) to Soybean which does not have any significant effect on the crop. Besides, there is a general notion that Soybean does not require fertilizer in order to thrive well, hence most farmers fail to apply fertilizer to the crop limiting its yield and competitiveness.

Basic agronomic practices such as planting in rows and deep method of fertilizer application are hardly adhered to by farmers which have significant effect on productivity of the crop. Insufficient number of measuring equipment to standardize produce in the markets also limits the competitiveness of local produce compared with imported ones. Quality of produce is crucial to pricing. Unfortunately, threshing of produce is mostly carried out on the bare floor resulting in discoloration of produce that has negative effect on the quality of produce as processors are compelled to clean and ensure a certain minimum standard.

A significant influencer of the cost of soy production is the interest rate of credit secured at the banks. The average interest rate at the commercial and rural banks as at 2016 was 32% per annum compared with rates below 5% in developed worlds. Issues of soybean post-harvest losses in Ghana have been a major problem for farmers over the years. The high post-harvest losses are extensive among varieties that easily shatter during harvesting.

Because of the large quantities of produce lost on the field at this stage, farmers do increase the price of the produce to cater for cost of production and possibly add some margins as profit. Recent statistics from USDA (2018) quantified the total domestic production of poultry to be 35 metric tons and total import to be 158 metric tons per annum. This creates a huge gap to be filled through domestic production of poultry that would rely on soybean for the formulation of poultry feed-soymeal.

2.9 Current Situation of Rice Value Chain in Ghana

Rice is an important food crop in the world and ranks second in terms of area and production (Arias, Hallam, Krivonos and Morrison, 2013). The crop is crucial to the development of nations as it plays a critical role in ensuring food security for the poor in both rural and urban settings (Nwanze, Mohapatra, Kormawa, Shellemiah and Bruce-Oliver, 2006). The commodity has gradually become a substitute for most food crops in the sub-Sahara Africa as a result of changing food preferences among the citizenry (Asante et al., 2014). As a result, its per capita consumption has doubled over a ten-year period from15kg in 2005 to 32kg in 2015 (MoFA, 2016). In terms of production, the commodity is produced in all ten administrative regions of the country, covering all agro-ecological zones, but the intensity of production varies depending on the form of production - rain-fed, irrigated and availability of valleys etc. With productivity level of 3.01mt/ha as against achievable yield of 6.00mt/ha total rice (paddy) production for the year 2016 was estimated to be 721,610 mt (MoFA, 2017). Figure 2.5 illustrates production by top five rice producing regions in the country over a three-year period, 2014-2016.

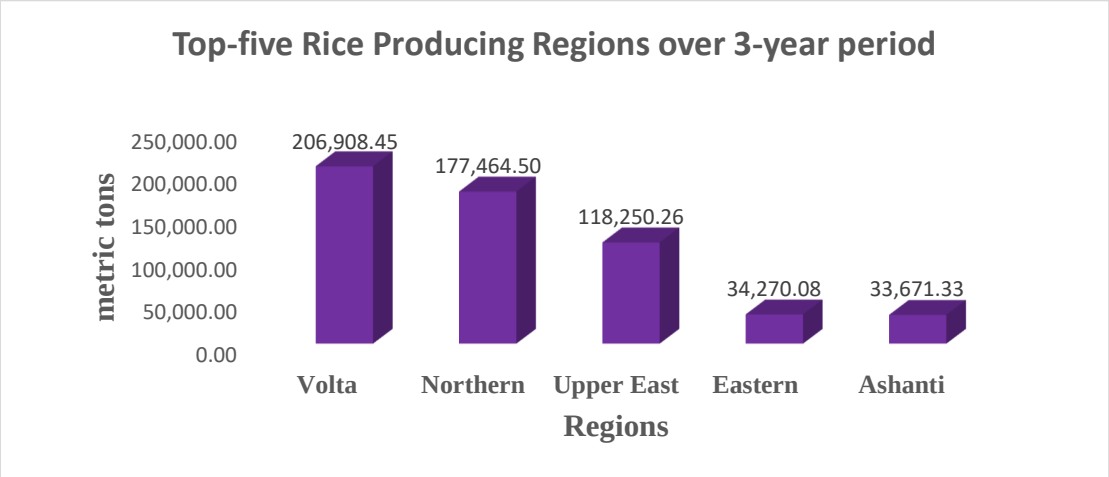

Figure 2.5: Top -five rice producing regions over a three-year period
Source: Statistics, Research and Info. Directorate (SRID), Min. of Food & Agric (2017).

Rice, as indicated has become a staple food for Ghanaians and is consumed across the country. Though the imported ones are usually patronized, the domestically milled ones are beginning to make some inroads. Local brands like *Avnash Royal Farmers*, produced by Avnash Company in Tolon District of Northern region, *Aduanehene and Copa brands* produced by Global Agricultural Development Company (GADCO) in Sogakope, *Edwumawura* rice produced by Worawora rice mill at Worawora and *Mr. Rabbit Jasmine* by Richland Company at Asutuare in the Greater Accra region are some of leading brands.

2.9.1 Constraints and Competitiveness of the Rice Value Chain

There are a number of rice varieties (e.g. *Jasmine 85, AGRA, Togo Mashall)* that have been released and some indigenous varieties such as *mandi, Gomba (brown rice), Lapex, Aflao, Amankwatia, Viwonor, Kawumo, Saudi Arabia* and *Akwa Blue* that are well patronised by consumers due to a number of factors. The large number of varieties in the country makes it difficult for a pure stand to be established on fields resulting in mixed varieties. The most

preferred local varieties (hence competitive with the imported varieties) are the "perfume" varieties such as Jasmine 85 and AGRA varieties. Poor seeding, as a result of broadcasting, leads to poor establishment of crops and reduction in yield. According to Ali *et al*. (2014), adopters of direct rice-sowing technology recorded higher rice yields compared to non-adopters of the technology. The rice yields were high in the range of 296 – 333kg per acre. Inadequate simple machinery at the disposal of smallholder farmers limits the mechanization during the production process. Simple machinery for land preparation, harvesting etc. would ease labour requirement on the field, which in itself, is readily non-available. Arora, *et al*. (2009) in his work on "Novel Adoption Index of Selected Agricultural Technologies: Linkages with Infrastructure and Productivity" indicated a positive relationship between use of machinery and agricultural productivity. More so, access to finance has also been a challenge to most smallholder farmers because of the high interest rates being charged by financial institutions. The high interest rates stem partly from the lack of trust in farmers to repay the loan and in some cases insufficient information/data about the farmer. The average interest rate on loans from commercial and rural banks as at 2016 was 32% per annum as against those in developed countries which is below 5%. Nonetheless, Ghana has a comparative advantage in rice production, hence can be very competitive with respect to other countries in the sub-region (Assuming-Brempong, 1998). What needs to be done is to close the yield gaps between achievable and actuals by adopting appropriate GAPs such as: using improved seeds; using suitable and right levels of agro-chemicals; timely provision of information and dissemination of knowledge to farmers; Enhanced access to finance at low interest rates; easy access and

application of appropriate farm machinery; improved access to markets; and investment into the upstream component of the value chain (e.g. milling machines), among others.

2.10 Theory of Change

Inter-disciplinary researchers working in a global community of implementation and improvement research currently focuses on systematic studies and testing of implementation processes and innovations in an attempt to find out what works out and what does not (UK Implementation Society, 2017). It is also becoming evident that deploying only experimental methods to assess the results of intervention that occur in a complex adaptive response might not be rigorous and effective enough to evaluate interventions programmes (Ghate, 2015). The design and implementation of intervention programmes across sectors in recent years have, therefore, been guided by the pursuit of cardinal goals that are Evidenced-Based (EB). These EB interventions hardly fail irrespective of their peculiar context, amidst the intractable challenges that might arise, provided they have been designed and executed according to laid down fundamental principles (Dick *et al.*, 2016). Results from these EB programmes have been overwhelming and attracted influential policymakers across the globe, mainly from Australia and USA to make substantial investments into it (Cartwright, 2011).

This EB intervention referred to as "theory of change" can generally be defined as a planned route to an outcome. It enumerates the logic, principles and assumptions that link what an intervention programme like ADVANCE, or a service undertakes and why and how it does it with its intended results (Rogers, 2008). It is a formal and explicit narration of the assumptions that underline the rational and assumption of an intervention

programme. It also explains why it is prudent to expect change of service for the beneficiaries. It will be useful to conceptualize the theory of change as a "Pathway to Change", a conduit and vehicle to change where service providers and users, as well as other actors, will "travel", moving from their initial or present needs or challenges to the final positive outcome the project seeks to achieve (Ghate, 2016; Renger and Hurley, 2006). The logical frame (Fig 2.6), a term synonymous with "theory of Change" denotes a pictorial representation of the theory in a concise form (Hawe, 2015). The components of theory of change are described briefly in the section that follows.

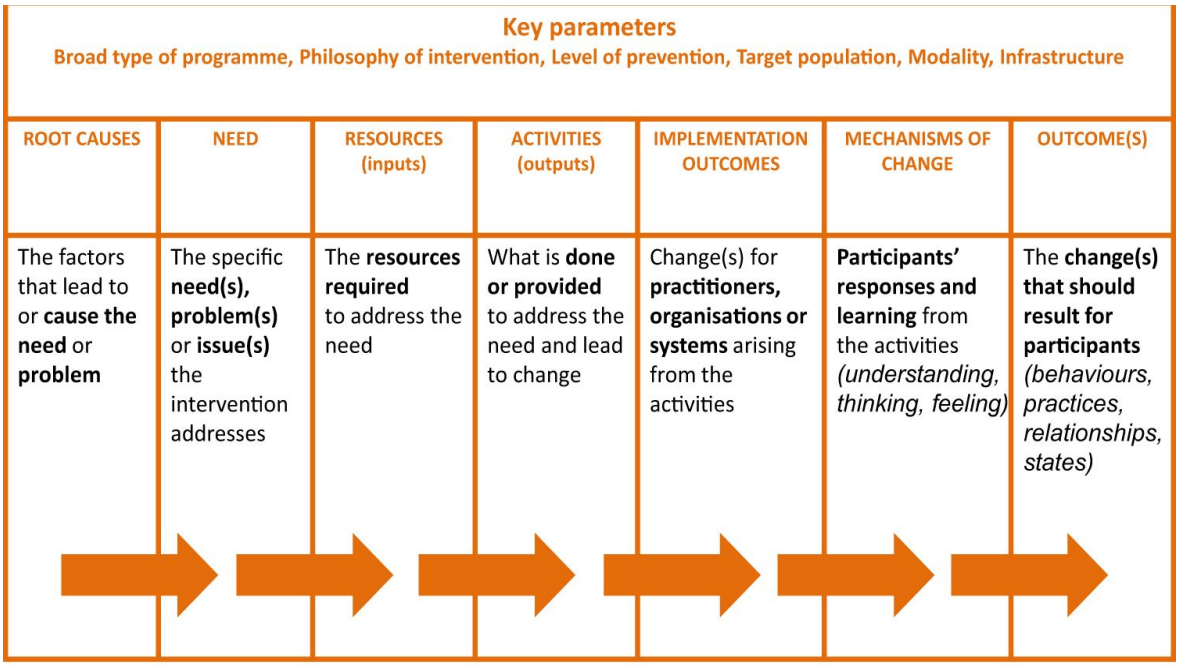

Figure 2.6: Logical frame theories of change for social programmes
Source: The Colebrooke Centre for Evidence and Implementation, 2017.

2.10.1 Components of Theory of Change

According to Ghate (2015), the components of theories of change take several forms but the fundamental elements must be present as well as *specifications of the implementation outcome at practice, organization or system levels* as well as the *mechanism of change*

(Weiss, 1997). These are required in achieving the expected outcome for the target beneficiaries. The fundamental elements of the theory of change include: *needs*, the initial problems to be addressed; *inputs* or resources required; *outputs* which are the intended activities to be undertaken and *outcomes* comprising the desired changes for service users. The *needs* are the "challenges" or deficits that ought to be addressed by the intervention programme (Campbell, 1979). These needs, in the context of the ADVANCE project are the low yield or productivity of the targeted corps (maize, rice and soybean) as well as inadequate market access of the commodities for the smallholder farmers. The root causes of the problem or need such as poverty, social inequality etc., are at times included in the theory even if they seem directly unrelated. Though some root causes are difficult to eliminate by single-factor solutions (Rittel and Webber, 1973), it is significant they are included in the theory of change to assist providers to recognize the intervention in its systemic context and as part of a bigger picture of incentive for change rather than as a single change agent. This prevents understatement of complex issues and keeps expectations realistic by avoiding situations where one is of the view that a single intervention is all that is needed to solve complex social problems.

Resources and activities: These must be correctly specified as they constitute the engine of implementation but are poorly defined if the programme is part of elements of established practice executed by established institutions. Activities herein refer to the content of the intervention being delivered. It spells out the specific pieces of training, messages or practices or methods to be deployed. With respect to the ADVANCE project, the activities employed have been categorized into two: The GAPs practices which include training of farmers in the use of certified seed, fertilizer application and row planting. The second

component is the market access strategies which consists of labelling of products, weighing/sorting and collective marketing. Resources, on the other hand, refer to the infrastructure in place to deliver the content. This could be the type and number of staff available (i.e. ADVANCE Chief of Party, Field Business Facilitators, Technical Directors, Production Managers, Seed Specialists, Commodity Chain Specialists, Grant Specialists among others) their competencies, equipment or gadgets/facilities etc. *Dosage*, the number of times or exposure expected and necessary to bring the required change in an average beneficiary of the intervention programme must also be included in the theory of change.

Implementation outcomes: These are often ignored during the specification of how programmes are expected to work, particularly when the intervention involves direct delivery to users where staff or intermediation are not needed. They are, however, significant in producing final treatment outcomes for service users. As indicated by Moran and Ghate (2013), just like all other outcomes, implementation outcomes must be viewed as changes arising as a result of the intervention programme. These changes might include changes in the organization itself (USAID/ADVANCE) to support the effective delivery of the programme or changes in the practices and behaviour of the individual staff. Implementation outcome with respect to the ADVANCE project could be likened to the several restructuring that took place after each annual assessment of strategies implemented such as changing the organogram of the organization/project and final relocation of the ADVANCE headquarters from Accra to Tamale in order to be effective and close to the beneficiaries of the project.

Mechanisms of Change: These are changes that occur concerning the beneficiaries, for instance increased yield, which are crucial to the specification of causality (Davies *et al*.,

2010). It is important to take into consideration the mechanism of intervention between delivery of the programme service and the occurrence of the outcome of interest (Weiss, 1997) to fully model and appreciate how the programme is expected to work. It must be recognized that specification of the key variables within the theory of change is vital as this defines the boundaries within which the intervention is intended to work.

2.10.2 Significance Theory of Change

Currently, there is a general appreciation of the importance of the theory of intervention before any meaningful assessment of intervention programme can be a gauge as to whether the intervention delivered was done consistent with its underlying theory (Moore et al., 2015). Thus, with the existence of a roadmap, it becomes easier to assess fairly based on established assumptions before the implementation of the project. Key elements embedded in the theory can now be assessed whether they were present at delivery and expected outcomes could be measured before, during and after the programme has been delivered. Though increasing evaluability is a cardinal benefit of having an expanded and detailed theory of change, it also creates the opportunity for testing the programme theory and refining, taking into consideration the results of the testing. According to Baker (2010), having a theory of change in place facilitates easy scale-up or replication of interventions as implementers get to know what is working and what is not.

Despite the glaring benefits of the theory of change, it does have some pitfalls. As noted by Mulgan (2016), most theories of change are not in its sense theories and do not necessarily support systematic thinking though they might give an impression of systematic thinking. There is also the issue of oversimplifying complex issues which might be misleading. This has been confirmed by Mowles (2014) that there are no simple

programmes not even complicated ones but only complex ones. Rogers (2008) went further to reveal that logic models might indicate some false sense of confidence as real-world challenges are often complex and multifaceted.

2.11 The Agricultural household model

An agricultural, or farm household in a developing economy like Ghana differs from the conventional economic household because the former produces and consumes some of the commodities they produce as well as supply some or all labour used on the farms (Strauss, 1984). A critical feature of agricultural households is the interlinkage of the production and consumption decisions; the extent of this interdependence depends on the size of the markets (Inderjit, 1985). Thus, the concept of agricultural households covers a continuum of households comprising those who are purely subsistence to commercial farmers. Most farm households in SSA are semi-commercial. However, given the potential advantages of commercialization to the farmer, both government organizations (GOs) and NGOs work at stepping up the commercialization drive of farmers.

As indicated earlier, this is what the ADVANCE project seeks to achieve, with the idea that if farmers commercialize, they stand the chance of increasing their welfare. In order to appreciate their present state of semi-commercialization and the dynamics of getting to the state of full commercialization, it is important for us to understand agricultural household models. That is to say it is imperative for any analysis examining the consumption and labour supply of agricultural households to take into consideration the interlinkage of consumption and production components because agricultural households modelling combines these two essential units of microeconomic analysis. The farm enterprise activities generate income which affects household consumption.

More so, most intervention and investment programmes such as ADVANCE were designed to increase the production of the targeted commodities (maize, rice and soybean) that has its primary impact on the yield hence income of the beneficiary agricultural households in the study area. The USAID/ADVANCE programme equipped beneficiaries with pieces of training in GAPs and marketing strategies to increase yield and enhance markets access for the smallholder farmers. The impact of the intervention programme, however, may not reach non-beneficiaries and other non-agricultural households in the catchment area. Nevertheless, the effects of the policy/intervention programme on non-beneficiaries and non-agricultural households are crucial in determining the actual impact of the intervention programme. A model that incorporates total labour demand and family labour supply would allow us to explore the effects of the intervention/policy on demand for hired labour and the income of landless or non-agricultural households or non-beneficiaries. Similarly, a model that captures the consumer behaviour enables the researcher to explore the consequences of increased profits for agricultural households who are beneficiaries of the intervention programme on demand for products and services provided by non-beneficiaries or non-agricultural rural households. Since the demand for non-agricultural commodities, which may determine the level of poverty, is usually assumed to be more responsive to increase in income than agricultural commodities, the spill over effects would be well represented. These semi-subsistence smallholder agricultural households who are predominant in Northern Ghana (Musah *et al*., 2014) are important for analysis to anyone in economic development because they are the target of the ADVANCE project with the view of enhancing their market access through labelling,

weighing/sorting and collective marketing on one hand and increasing yield via adoption of improved seeds, row planting and fertilizer application on the other.

According to Taylor and Adelman (2003), as indicated in Donkoh (2006), farm households that do not have access to markets had no prices for inputs and outputs hence no opportunities to exchange food for leisure. Such households, face a production possibility frontier (PPF) showing a trade-off between producing food and consuming leisure (Fig. 2.7). In the absence of access to labour markets, households must supply their own labour and food supply cannot increase without sacrificing leisure - Thus, $C_l^c = \bar{T} - L_f^c$ where the superscript "c" denotes market constrained). The household could also allocate all of its time to leisure and produce no food $\left(C_l^{\max} = \bar{T}\right)$, or sacrifice leisure to increase the production of food in line with its production technology. With a given fixed capital (i.e. in the short run), the curvature of the PPF depicts diminishing marginal returns to labour in food production, implying leisure is sacrificed to increase food production. Farm households, however, would achieve maximum food output should they allocate all of their time to food production which can be stated as $Q^{\max} = Q_f\left(\bar{T}, \bar{K}\right)$. This extreme situation where markets are absent reveals a Chayanovian scenario (Taylor and Adelman, 2003) where households face severe labour-leisure trade-offs. The resultant PPF, therefore, is the de-facto budget constraint.

As shown in Fig. 2.7, the points A^1, A^{11} and A* indicate the equilibrium condition because the marginal rate of transformation (MRT) of leisure to food (slope of PPF) is equal to the marginal rate of substitution (MRS) (slope of indifference curves). The point A*, however, indicates the highest achievable utility (in the case of no markets) as it is on a higher

indifference curve I_2 with respect to I_1. The optimal (market constrained) consumption/production levels at this point is therefore $Q_f^c = C_f^c$ and C_l^c.

Admittedly, this model is very suitable but the underlying assumption of non-existence of markets limits the chances of specialization with further effect of restricted output.

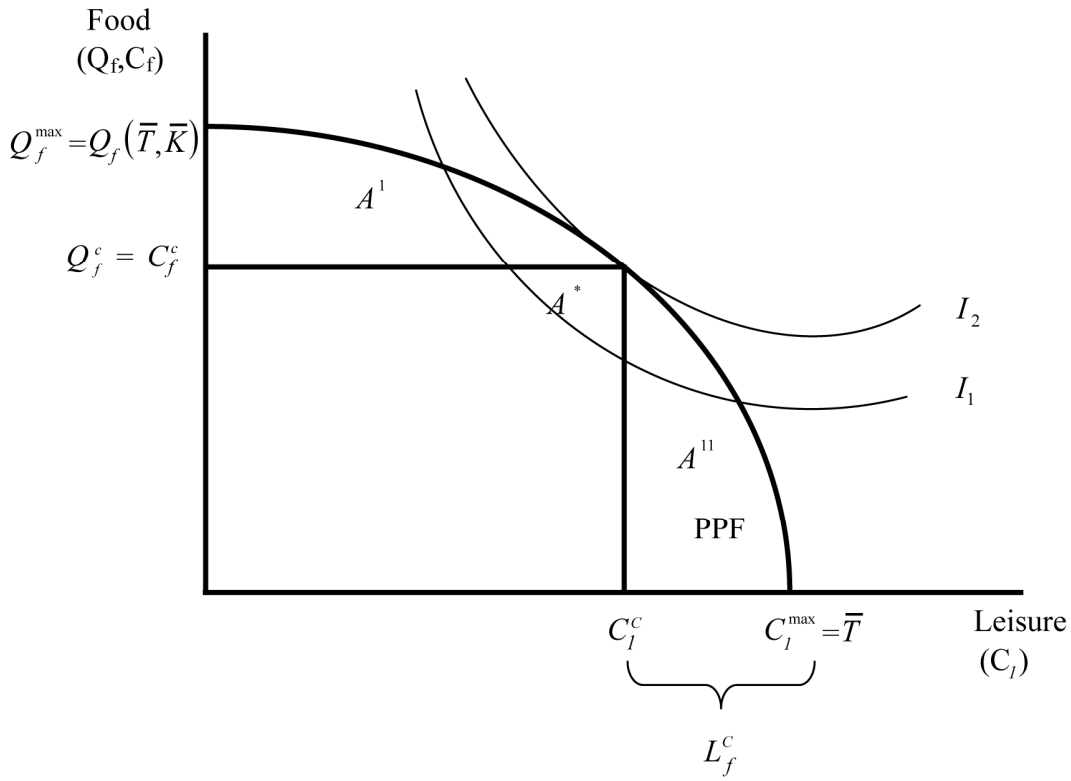

Figure 2.7: Agricultural household with no market

Source: Donkoh (2006)

In view of the limitation of the Chayanovian scenario where household face severe labour-leisure trade-offs, the perfect market neoclassical model was developed. This new model has existing market for all households and prices are exogenously determined. Thus, labour can be hired hence no trade-off between labour/work and leisure with household producing food at any point on the production possibility frontier (PPF) without sacrificing time for

leisure (Fig. 2.8). Since prices for both goods and inputs are available, the market price line/budget line would have a slope equal to $\frac{-w}{P_f}$, (where w = wage rate of labour and P_f = price of food; w and P_f are exogenous to the household) now interpreted as the marginal rate of transformation, (*MRT)* at point B, where households maximizes their production. This point B, nevertheless, is still beneath the two indifference curves, I_1 and I_2 that represent the household utility maximization. Thus, though production is maximized, household consumption utility is not. Subsequently, the household uses market to trade to its optimal consumption point at C, where the ratio of market prices equals the marginal rate of substitution between leisure and food. If food production exceeds household consumption demand (Fig. 2.8), the surplus is sold. Profits from the sales (crop), would provide cash to hire labor in order for the household to produce more food without reducing leisure.

The net hired labor equals amount of labour required to produce profit maximizing output, L_f^* , less the household's labor supply, given as the difference between the total time and leisure ($\bar{T} - C_l^*$). Households hires labor if $L_f^* > \bar{T} - C_l^*$ and sells labor if $L_f^* < \bar{T} - C_l^*$

Although, utility is maximized at point C, the total utility at point E is still higher (than that at C) because E is on a higher indifference curve. The outward shift of PPF attributable to an improvement in technology (e.g., use of improved seeds and planting in rows) makes production more efficient, i.e., more output produced with same resources. From Fig. 2.8, an increase in price (P_f) with no change in nominal wage rate results in the fall in real wage rate, $^{w}/_{P_f}$ with subsequent flattening of the market price line $^{w}/_{f1}$ (as against $^{w}/_{P_f}$). The household would, therefore, maximize its output at point D, where slope of the market line

and *PPF* are the same. Thus, at this new point D, the quantity of output is higher compared to point B before the fall in food price (assuming there is a positive price elasticity of food supplied). Nonetheless, the existence of markets enables trading by households to optimize at consumption point E due to higher profits derived from higher food prices, assuming, *w* remains unchanged. It must be noted that the production decisions made are not dependent on the consumption decisions, yet the latter is influenced by the former through the budget line or price line.

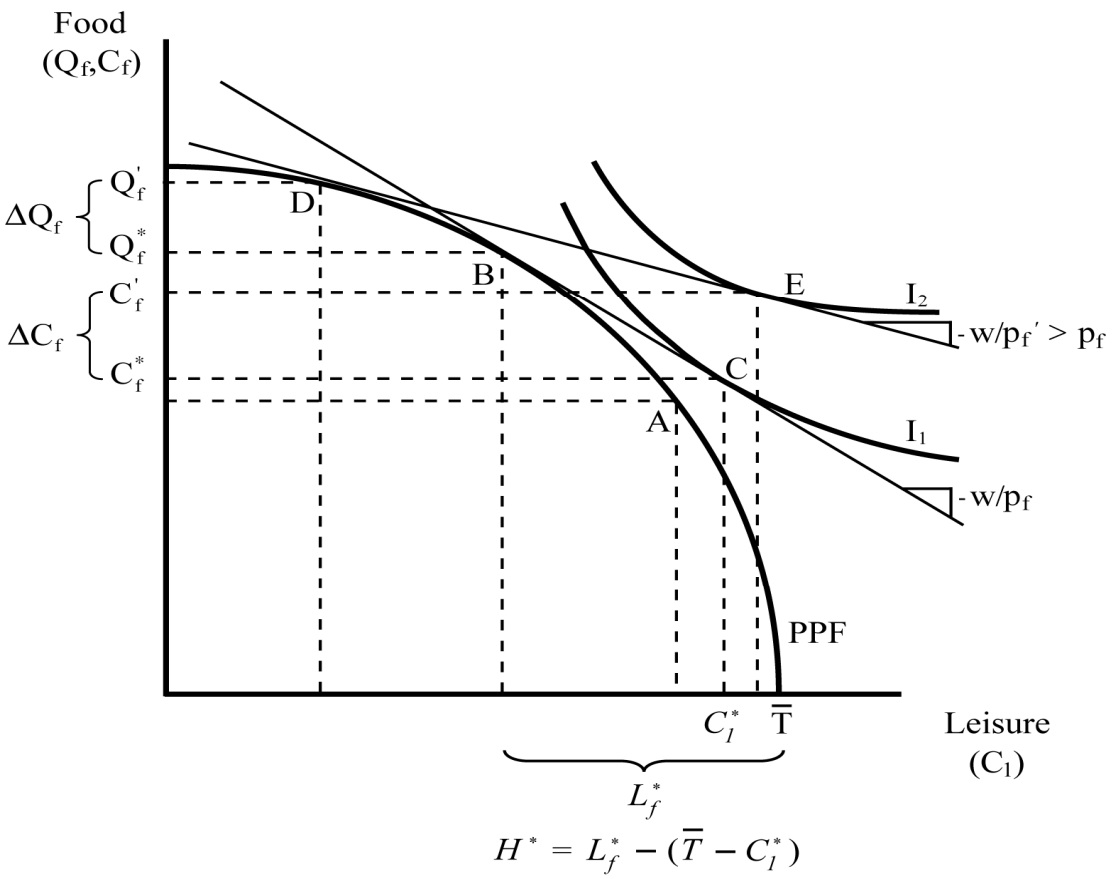

Figure 2.8: Agricultural household model with perfect markets

Source: Donkoh (2006)

2.11.1 Application of Agricultural Household model

The primary goal of the USAID/ADVANCE intervention programme is to facilitate the transformation of Ghana's agricultural sector by leveraging on certain commodities to achieve enhanced competitiveness in all market segments, be it domestic, regional or international (ADVANCE annual report, 2010). This was to be achieved through enhance market access and increase productivity of the farmers. The enhance market access activities include labelling of products, sorting/weighing and collective marketing while the increase yield activities encompasses use of improved seeds, planting in rows and fertilizer application.

Enhancing the market competitiveness of farmers suggests that they are expected to produce not only for domestic consumption but for commercial purposes as well. This implies that as a consumer, the smallholder farmer would choose the allocation of income from farm profits as well as labour sales to the consumption of goods and services whiles a producer, the farm household would choose the allocation of labour and other inputs to crop production. The farm profits therein include implicit profits derived from goods produced and consumed by the household and consumption comprises both self-purchased and purchased goods. The above scenarios are plausible because of the existence of markets and the project's goal to facilitate the transformation of subsistence farming into a commercial one in the former Northern Ghana.

2.11.2 Mathematical Analysis of Agricultural Household model

Since the agricultural household produces and consumes some of their produce as well as supply some or all the labour, the decision process will capture both production and consumption functions.

Taking into consideration the production function

$Q = (C(L, H, V)$

Where $Q =$ Quantity of harvested food produced (e.g., maize, rice or soybean) ; $L =$ Labour ; $H =$ Land and $V =$ Fertilizer;

Profit function, π expressed in terms of revenue generated against cost can be specified as;

$\pi = P \cdot C(L, H, V) - wL - rH - \mu V$

Where $P =$ Price of the harvested product, ; $w =$ Price of labour; $r =$ Price of land; $\mu =$ Price of Fertilizer

Assuming that the smallholder farmer owns the land and will not have to pay rent for land, then $r = 0$

$\pi = P \cdot C(L, H, V) - wL - \mu V$

Thus, the profit of the small farm holder is a direct function of the physical quantities of land, labour and fertilizer and an indirect function of the unit costs of land and fertilizer

Given that the mathematical illustration of the Agricultural household model is not the focus of the study, the research limited himself to the above key points. A detailed `representation of the Agricultural household model is well elaborated in Taylor and Adelman (2003).

CHAPTER THREE

3.0 LITERATURE REVIEW

3.1 Introduction

In this chapter, literature on the concepts, theory and empirical studies on adoption and impacts of adoption on household welfare are presented. It starts by giving the definitions, concepts of theory of change and adoption and measurement of adoption as detailed in the literature, particularly agricultural literature. Empirical evidence of determinants of technology is also detailed. An overview of impact evaluation, various approaches used in measuring impact of programme participation or adoption of agrarian technology is also captured in this chapter. Finally, the study presents empirical studies on the impact of programme participation or adoption of agriculture technology on farm households' welfare. A comprehensive understanding of these concepts, coupled with empirical evidence, provides insights into the significance of the study.

3.2 Concepts of Adoption of Farm Technologies

According to Feder *et al.* (1985), development and diffusion of new farm technologies present great opportunities for most rural farm households in less developed economies like Ghana whose main source of livelihood is agriculture. It is therefore, imperative for technology to drive innovations in the agricultural system. Numerous studies have defined technology in various ways. According to Lavison (2013), technology is the knowledge or information that allows specific tasks or service to be undertaken with less effort. It thus aims at making a particular situation better or changing same to more acceptable and desirable level. Technology users are, therefore, expected to perform assigned tasks easier

as time and labour are usually saved (Rossi, Caffi, & Salinari, 2002). The term was also generally defined by Loevinsohn *et al.* (2012) as all the processes, means and methods employed in producing goods and services including ways of organizing as well as physical techniques.

Adoption, however, is the integration of a new technology into an already existing one and is often preceded by periods of trials to facilitate assimilation and adoption by the target group (Loevinsohn *et al.,* 2012). Researchers such as Bonabana-Wabbi (2002) define adoption as a mental process that an individual traverses from the time of hearing the innovation/technology to the final stage of utilizing the innovation. Adoption as described or conceptualized by Rogers (1962), is the "mental process an individual pass from first hearing about an innovation to the final adoption". This conceptualization is in line with that of Namara *et al.* (2007) who defined adoption as an act of accepting an innovation or a technology with endorsement. Adoption itself can be put into two subgroups: the rate of adoption and the intensity of adoption. The former has an element of time as it can be said to be the speed with which a farmer adopts an innovation whereas the intensity is the depth or level to which the technology has been used within a given period of time (Rossi *et al.*, 2002). Rogers (1995) gave a similar definition of adoption but went on to group the adoption process into five-step process: 1) knowledge – which entails being aware of the technology and therefore referred to as the awareness stage; 2) persuasion (interest) stage where farmers begin to gain interest in the technology as people become aware of it.; 3) decision (evaluation) where information about the expected benefits of the innovation and its ease of use are collected. If the farmer finds adequate information and the assessment is positive, then the farmer may move to the next stage; 4) implementation (trial) – this is

where the farmer experiments the innovation. For instance, a farmer may divide his/her two-acre plot of land into two, where an acre will be used for the planting of an improved variety of rice. 5) confirmation (adoption) – if the farmer is convinced of the benefits and the ease of technology, then full-scale adoption takes place. Throughout the entire adoption process, the individual seeks knowledge and skills which ultimately affect the adoption process. For a potential adopter, however, the process will proceed through the various stages until adoption finally takes place, or alternately, leads to rejection of the innovation.

Though extensive research has been conducted into technology adoption in agriculture since the pioneering work of Griliches (1957) on adoption of hybrid corn in the USA, the definition of technology adoption is still problematic as it varies with the type of technology being adopted. In the case of African Center for Biosafety (2012) farmers were classified as adopters if they had used improved seed that were recycled for several generations from hybrid ancestors. Whereas, Doss (2003) and Ouma, *et al.* (2002) identified adopters as farmers who implemented recommendations from extension providers to use new certified seeds. Notable researchers such as Low and Meghir (2017) defined technology adoption as the frequent use of an innovation or technology by some economic agents.

Feder *et al.* (1985), for the purpose of theory and empirics, clearly defined adoption with regard to individual adoption, known as farm-level adoption and aggregate adoption. Feder *et al.* (1985) conceptualized individual or farm-level adoption as the degree of use of an innovation in the long-run when the farmers have full information about the innovation and its potential returns. However, aggregate adoption was defined as the cumulative use of the technology among a population in a given geographical area. That is, aggregate adoption

can be defined as the spread of a given innovation within a particular society or community (Thirtle and Ruttan, 1987). However, Feder *et al.* (1985) referred to this process of spread as diffusion process of a given technology.

Rogers (1983) also distinguished between adoption and diffusion and described the former as the use and disuse of a technology by a farmer at a chosen period of time and the later as the process by which technology is transferred through specific communication channels to other members in the social system. The diffusion process is, therefore, categorized into the following four classes as 1) the innovation that represents the new knowledge to be diffused; 2) the medium of transfer of the technology via extension workers and technology suppliers to the intended beneficiaries or final users; 3) the duration or period for adoption of the technology; 4) and finally the social system. An earlier but crucial aspect of technology adoption particularly with respect to agricultural technology is that it is "location specific". Technologies developed under different climatic conditions with varying degrees of resource endowments might not necessarily and easily be transferable to other parts of the world. Technologies that have something to do with production methods and process as well as seed varieties and machinery require appreciable local adaptation to fit into the agro ecology and the economic environment. This has been the bane for Africa countries not benefiting from the green revolution because western technologies were directly transferred into Africa without allowing for adaptation, experimentation and knowledge build up to adapt to the local settings (DeGraft-Johnson *et al.*, 2014).

Moreover, differences in cultural habits and norms do not encourage the ease of citizens to learn easily from one another due to the seeming misconceptions, misunderstanding,

discriminations and other social barriers (deGraft-Johnson *et al.*, 2014). Lastly, as stated by Guiso *et al.* (2009) countries with similar genetic characteristics are more likely to trust each other, and thus, have the higher probability of technology transfer.

Adoption of agrarian technologies may come as a single or individual technology (e.g., tractor or planter) or as a form of package (e.g., row planting, improved crop variety, fertilizer, insecticides, etc.). In a situation where technologies come as a package, some components may be adopted as substitutes to others while others have to be adopted as complements. In the latter case, there ought to be a simultaneous diffusion and adoption by farmers to complete the full package (Feder *et al.*, 1985). Thus, adoption of such package follows a distinct and sequential pattern of adoption (Mann, 1978). Moreover, Feder *et al.* (1985) made a clear-cut distinction between divisible technology and indivisible technology. The divisible are those technologies that do not necessarily need to be applied to the whole farm. For instance, a farmer can plant some portion of his/her farm with improved soybean seeds while using the local variety on the remaining part of the farm. However, with indivisible technology, the farmer needs to apply it to the whole farm (e.g. tractor or combine harvester). With regard to the divisible technology, the extent or intensity of adoption can be defined as the share of the farm land allocated to the use of the new technology or amount of inputs used per hectare. For indivisible technology, the extent of adoption is just a dichotomous (either the farmer uses or not). In measuring the intensity of adoption in aggregate, the extent or degree of use becomes continuous. For instance, the number of farmers using that innovation. The aggregate level of use of the technology becomes the level of adoption (Beshir, 2014). Beshir (2014) distinguished between the rate of adoption and the extent of adoption. The rate of adoption is the proportion of farmers

using the technology while the intensity or degree of adoption is the percentage of farmers using that technology at a particularly period.

It is therefore imperative for any researcher to consider whether the adoption of a new technology is a discrete or not (Doss, 2003) in an attempt to define it. This implies that a farmer takes the value of zero or one if he/she is a non-adopter or adopter, respectively or the response is a continuous variable (Challa, 2013). Other researchers apply the simple dichotomous variable procedure in finding out farmers' decision to adopt a new technology. This is, however, not satisfactory (Jain *et al*., 2009) as one's dichotomous response could only reflect one's level of awareness of the innovation, and not necessarily its adoption. In view of this, scholars must indicate how technology adoption is defined so as to develop appropriate tools to measure it.

In this study, there is a complete diffusion or universal awareness of GAPs and marketing strategies since all farmers in both the programme catchment and non-catchment areas are aware of the ADVANCE intervention programme. Thus, the data shows that there is no farmer that expresses lack of awareness of the programme. These GAPs and marketing strategies are being disseminated through ADVANCE field officers, nucleus farmers, MoFA extension officers, farmer –to-farmer extension, among other channels. Hence, the study defined adoption as participating in at least one of the GAPs and marketing strategies.

3.3 Measurement of Farm Technology adoption

Literature suggests a number of econometric techniques used in modelling farm technology adoption behavior of smallholder farmers and ways to identify the key determinants of technology adoption decision contingent on the specific objective of the study (Shiferaw *et*

al., 2008; Yesuf and Köhlin, 2008). Farmers' decisions on adoption of a new technology in empirical literature are mostly measured by econometric modelling, usually referred to as the discrete and limited dependent choice modelling. These include dichotomous choice models such as probit (Kassie *et al*., 2011; Uaiene *et al*., 2009; Kehinde and Adeyemo, 2017) or logit (Gregory and Sewando 2013; Idrisa *et al*., 2012), a continuous dependent variable with range of zeros such as double hurdle (Teklewold *et al*., 2006, Awotide *et al*., 2016; Obuobisa-Darko, 2015) or Tobit models (Idrisa *et al*., 2012; Danso-Abbeam and Baiyegunhi, 2017). Count data models such as standard Poisson (Lorh and Park, 2002, Nkegbe and Shankar, 2014, Ehiakpor *et al*., 2016) or negative binomial models (Sharma *et al*., 2011, Isgin *et al*., 2008), and selection bias models such as Heckman two-stage models (Ibrahim *et al*., 2012, Kansiime *et al*., 2015) are employed for count events and continuous dependent variables with selection bias, respectively. Multiple response models such as multivariate probit (Ahmed, 2015; Donkoh *et al.*, 2019, Ponguane and Mucavele, 2018) or multinomial logit (Teklewold *et al.*, 2013, Danso-Abbeam and Biayegunhi, 2018) as well as multivariate Tobit are also used in a situation where farmers are to adopt some innovations in multiples dichotomy (in case of multivariate or multinomial) or multiple continuous with zeros (in case of multivariate Tobit). However, when responses are ordinal or index, then ordered logit or probit (e,g, Maguza-Tembo *et al.*, 2017) are useful.

Dichotomous choice models such as logit or probit are usually used to measure the adoption of technologies that are not divisible such as adoption of tractor or planter or a case where the data in question is qualitative in nature. For example, "yes" or "no", "agree" or "disagree", "use" or "not use", "like" or "dislike". In both logistic or probit regression models, the binary dependent variable must be coded 1 and 0. Moreover, both models can

be used to examine the relationship between/among one or more explanatory variables and a categorical dependent variable. The difference between probit and logit model is theoretical. Probit is based on the standard normal distribution of the error term while logit relies on logistic distribution (Maddalla, 2005). With regard to the functional form, logit uses a logit link function whereas probit uses inverse normal link function. When logit and probit models are estimated, the difference in the results are so insignificant and sometimes even non-existing. This makes it practically difficult to choose between logit and probit (Greene, 2008). A binary dependent model like probit and logit can only explain the probability of occurrence or non-occurrence but not the degree of occurrence. For instance, using logit or probit to assess the adoption of improved variety of crop is not sufficient to examine the extent of adoption. Probit or logit model lacks the ability to estimate multiple responses jointly. Thus, in situations where several probit or logit models have to be estimated jointly, multinomial or multivariate models are used.

Multinomial logit and probit models have the capacity to handle three or more responses that are assumed not to be correlated. That is, in multinomial logistic model, more than two possible discrete outcomes are used under the assumption of Independence of Irrelevant Alternatives (IIA) (Greene, 2000; Train, 2003). Under IIA, the error terms containing observed covariates are assumed to be uncorrelated over the multiple outcome or responses. However, where the possible outcome variables are assumed to exhibit some level of correlation, then the Multivariate Logit/Probit Model (MVL/P) is usually used. For instance, the MVP consists of several correlated probit models that are estimated jointly (Danso-Abbeam and Baiyegunhi, 2017). The MVP estimates the set of binary probit models simultaneously by recognizing the correlation in the error term of each model. One

advantage of the MVP is that it permits the relationship between adoption of different technologies to be established and the possible correlations between the error terms (Yu *et al.,* 2008; Kassie *et al.,* 2009; Ahmed 2015). However, like the logit and probit models, both multinomial and multivariate cannot handle a situation where the intensity of adoption has to be estimated.

One of the models that have the ability to handle the intensity of adoption is the Tobit model developed by Tobin (1958). Tobit model is usually used when the outcome variable of interest is censored at zeros. Thus, the model incorporates all responses including zero responses. The Tobit model is a combination of discrete dependent variable and a continuous dependent variable where there are continuous effects of the covariates on the outcome variables. In Tobit model, the joint effects of the factors affecting the likelihood of adoption and the intensity of adoption is estimated at the same time (Adesina, 1996; Waithaka *et al.,* 2007; Wiredu *et al.,* 2015; Danso-Abbeam and Baiyegunhi, 2017). Nevertheless, this assumption of joint effects has been heavily criticized in recent literature (see Wiredu *et al.,* 2015). The critics of the Tobit model argue that the likelihood of adoption and the intensity of adoption may not necessarily be joint, hence, using Tobit for a separate decision-making may lead to bias estimates and result in wrong policy conclusions.

Heckman (1976) suggested a model that addresses the issue of joint effects of factors that simultaneously affects the discrete and the continuous decisions, arguing that censored estimation may result in sample selection bias. Hence, Heckman two-step estimation procedure is capable of handling respondents' decisions to participate in a programme (probability) and the extent of participation (continuous decisions) separately (Dow and

Norton, 2003; Mal *et al.*, 2012; Yirga and Hassan, 2013). Heckman (1976) proposes that the discrete decision making (probability) should be estimated with a logit/probit model while the continuous decision is estimated with OLS estimator. As opposed to the Tobit model, Heckman's two-step estimation procedure assumes that different set of explanatory variables could be used at each stage of the estimation procedure. Moreover, the model deals with problem of sample selection bias that may emanate from the two error terms having correlation greater than zero by imposing exclusivity in the first stage (Heckman, 1979; Adeoti, 2009; Johannes *et al.*, 2010). The Heckman model differs from the Tobit model in two main ways: (1) Heckman considers the process to be a two-stage procedure, and (2) it allows different predictors to be used in both stages of the estimation process. Hence, Heckman's model can be considered as a generalization version of Tobit and is, therefore, called the Type II Tobit.

Cragg (1971) made a modification to the Tobit model under the assumption of distinct and independent decisions by respondents. According to Cragg (1971), two models should be used to overcome this in order to have or observe positive responses from the respondents and hence, the name 'Cragg double-hurdle model'. The Cragg double hurdle model also recognizes that different set of variables explain the probability of participation in a programme and the extent of participation (Beshir, 2014). One key feature of the Cragg's double hurdle model is the assumption that the error term of the first and the second stage of the estimations are independent of each other (Beshir, 2014). In this case, the Cragg's double hurdle model would be similar to the combination of binary and truncated regression.

There are cases in survey data where the outcome variable of interest (dependent) is observed as a count event. When the dependent variable is a count in nature, then theoretical literature suggests a count data model to handle such situations. The standardized Poisson regression model proposed by Cameron and Trivedi (2006) is the most popular regression model employed in a situation where the outcome variable of interest is in aggregation or count in nature. The count data usually have zeros or even excess zeros that come as result of non-observation of positive values. A number of models have been developed to handle such situations. These include; standard Poisson, Negative Binomial, Zero-inflated Poisson and Zero-inflated negative binomial (Baum, 2016; Yusuf *et al.,* 2017). The starting point for analyzing count data models is the use of Generalized Linear models (GLM) with the error term having the Poisson distribution. However, some of the count data set do not meet the assumption of Poisson distributed error term (Yusuf *et al.,* 2017). It is, therefore, significant to perform a diagnostic test on the magnitude of the variance and the mean and whether there are excess zeros. The fundamental assumption of the standard Poisson regression is *equi-dispersion* where the mean of the error term is equal to the variance. However, the variance may be greater or less (though not usually observed in practice) than the mean. In a situation where the variance is greater than the mean, the distribution of the error term would not follow the Poisson distribution but a negative binomial distribution. Hence, Negative Binomial regression would be more appropriate (Baum, 2016). However, both standard Poisson and Negative-Binomial models lack the capacity to handle too many zeros (Hinde and Dimetrio, 1998).

The zero-inflated Poisson model deals with count data that exhibits equi-dispersion but has excess zeros while zero-inflated negative binomial is usually for over-dispersed count data

with excess zeros (Lambert, 1992, Bekebe and Gurge, 2010; Takahiro *et al.,* 2014). Moreover, theory suggests that the excess can be modelled separately using logit regression since they are generated by a separate process from the count (Lambert, 1992; Yusuf *et al.,* 2017). Yet, another variant of count data appears when no zero response is observed or recorded. That is, when only positive integer values are recorded. In such situations, Zero-truncated Poisson or Zero-truncated negative binomial is the most appropriate.

3.4 Empirical Evidence on the Determinants of Agricultural Technology Adoption

The key argument in outlining the factors that influence adoption of agricultural technology has to do with a farmer's decision as to whether to adopt a technology or not which is conditioned by the dynamic interactions between the peculiar characteristics of the technology itself and the conditions and circumstances that evolve around the technology (Loevinsohn *et. al.* (2012). The rate of diffusion of the technology is also as a result of the comparison between the associated intended benefits of the new innovation and the uncertain cost of adopting the technology. An appreciation of the underlying factors influencing these decisions is therefore crucial for both researchers studying the determinants of the innovation as well as extensionists disseminating the technology. An attempt to explain the adoption behaviour of farmers has attracted a number of scholars to classify the determinants of agricultural technology adoption into various categories according to what they perceived as factors driving the adoption behavior of the target population as well as available information at the disposal of the author[2]. Borges *et al.,*

[2] It is important to mention that the author is yet to know from literature a clear-cut justification for these classifications.

(2015) for instance categorized the factors influencing the adoption of agricultural technology into five main groups namely: farmer characteristics, household characteristics, farm characteristics, farm settings and acquisition of information.

Studies such as Feder *et al.*, (1985), Koppel (1994), Foster and Rosenzweig (1995), Kohli and Singh (1997), Rogers (2003) and Uaiene, (2009) grouped the determinants of technology adoption based on personal characteristics and resources, risk, institutional constraints, input availability, imperfect information, uncertainty and the available infrastructure at the disposal of the farmers. Nowak (1987), however, categorized them into ecological, informational and economic factors while Wu and Babcock (1998) categorized them into four broad areas as human capital, production, policy, and natural resource characteristics and endowments. A study undertaken by Akudugu *et. al.* (2012) classified the determinants of agricultural technology adoption into three as economic, social, and institutional factors. Despite these numerous classifications of factors affecting adoption of agricultural technology, there are no clear distinctions among the factors in each category. The classification is often done to suit the technology under review, the location, or the researchers' preference (Bonabana-Wabbi, 2002). This study will classify and review the factors affecting adoption of agricultural technology according to household demographic characteristics, household assets, institutional variables and location variables.

3.4.1 Household demographic characteristics

Many studies (see Nmadu *et al*. 2015; Denkyira *et al.* 2016; Danso-Abbeam *et al*. 2018; Danso-Abbeam and Baiyegunhi, 2019) have indicated the significant effects of household demographic characteristics such as age, marital status, household size among others. on

programme participation and adoption of farm technologies. The effects of age on technology innovation have been mixed. One strand of literature argues that age is a positive function of adoption, in that older farmers may know their production environment better than the younger ones due to experience. The other strand of literature contends that as farmers age and get experience in the farm operations, they become more risk-averse and hence, are less likely to adopt. For instance, while Islam *et al.* (2012) indicated the positive significance effects of age on the adoption of improved variety of rice, Danso-Abbeam *et al.*, (2014) posited a negative significant effect of age on the use of agrochemical management practices among smallholder cocoa farmers. While admitting that age is an important determinant in technology adoption, Ali *et al.* (2014) in assessing the impact of direct rice-sowing technology on rice farmers' earnings in Pakistan, realized a negative relationship between age and adoption of direct rice-sowing technology. This may be because of the anxiety of younger farmers to experiment new innovations while older farmers are used to their conventional methods of sowing rice and are unwilling to step out of their comfort zones to try new technologies. We may therefore concede that age may have negative influence on access to information because older farmers might be risk averse and reluctant to gather information about new technologies. A similar study conducted in Malawi by Lunduka *et al.* (2012) concluded that older and experienced farmers are more likely to adopt recycled hybrid maize seeds than younger and inexperienced farmers. Ojo and Ogunyemi (2014) also had similar results with regard to the effect of age on adoption of farm technology.

Another study on the adoption of agrochemicals among plantain farmers in Ghana was conducted by Egyire *et al.* (2011). The authors applied logistic regression model and found

that females have the potential, just like males, to use improved agricultural technology such as pesticides, herbicides and fertilizer. In another study by Denkyirah *et al.* (2016) on the adoption of cocoa pesticides, it was indicated that male farmers have a higher likelihood of adoption compared with the female farmers. In a similar study, Ndiritu *et al.* (2014) compared gender differences in the adoption of sustainable agricultural practices and reported that women have lower propensity to adopt as compared with their men counterparts.

Farm technology adoption has been hypothesized to respond to family labour supply which is usually a proxied by household size in most literature. The effects of household size on the adoption of agrarian technology have also been mixed. This is fundamentally because, while some studies estimate a positive effect of household size on adoption because it provides free labour, others also report negative effects due to the fact that large household size competes with farm inputs for available resources. Martey *et al.* (2015) estimated a positive effect of active family labour force on the participation of multi-stakeholder platform. Moreover, Sodjinou *et al.* (2015) used probit regression model to estimate a positive and significant effect of household size on the adoption of organic cotton.

Many other studies have provided empirical evidence to support the positive effect of education on farm productivity through adoption by shaping farmers' decision-making process. For instance, education enhances farmers' ability to access production and market information so easily. In a study to identify the determinants of sustainable agricultural practices with MVP model, Ahmed (2015) reported a significant relationship between education and adoption of fertilizer and soil conservation practices among rural maize farm households in Ethiopia. Similarly, Gebresilassie and Bekele (2015) concluded that farmers

with higher level of educational attainment have a greater propensity of allocating a larger proportion of their land to hybrid seeds.

The positive and significant effects of non-farm and off-farm economic activities have been evident in many empirical agricultural studies. Awotide *et al.* (2016) and Mmbando and Baiyegunhi (2016) estimated a positive influence off-farm economic activities on the adoption of agrarian technologies among farmers in Nigeria and Ethiopia, respectively. Moreover, Marechera and Ndwiga (2015), as part of their studies, estimated the determinants of aflatoxin control technology among rural Kenyan farmers using logistic model and OLS estimator. The study concluded that one of the key determinants of farmers' adoption of aflatoxin control technology and the extent of use is number of years in formal education.

3.4.2 Household assets

Ownership of households' assets such as land, livestock, bicycles, motorbikes, television, radio, donkeys, among others, have been documented in the empirical literature to have a higher propensity to enhance adoption of farm technologies. These assets increase households' access to information and hence, boost the probability of adoption. Challa and Tilahum (2014) noted that as households' asset improves, their cash incomes also go up, thereby enabling them to procure other farm inputs to complement the farm innovations. Ehiakpor *et al.* (2018) posited that households' assets such as tricycles and motorbikes enable farm inputs to be easily transported from farmers' houses to the farm and hence, increases the probability of technology adoption. In Zambia, Arslana *et al.* (2014) identified the factors influencing adoption of conservation practices using random effect

Tobit and fractional probit models. The empirical findings indicated that land per capita and other agro-ecological variables were estimated to influence adoption and intensity of adoption. Danso-Abbeam and Baiyegunhi (2018), as part of their study which seeks to evaluate the impact of pesticides management practices in Ghana's cocoa industry, estimated the adoption of pesticides management practices using multinomial logit regression model. Their empirical results suggested that farm size, ownership of motorized and hand-spraying machines contributed significantly to the probabilities of adopting both insecticides and fungicides. Applying multivariate probit model, Danso-Abbeam and Baiyegunhi (2017) and Kassie *et al.* (2015) also estimated a positive and significant effects of plot size on fertilizer adoption. However, a significant and negative correlation between some farm characteristics such as plot size and slope of land and adoption of agricultural management practices were established by Teklewold *et al.* (2013) and Kassie *et al.* (2013a).

3.4.3 Institutional and policy variables

Institutional and policy variables have been identified in many empirical studies as key determinants of adoption in most developing countries. Awotide *et al.* (2016) applied a Tobit model, where the intensity of adoption was conceptualized as the fraction of total farmland assigned to the cultivation of improved rice variety. The empirical findings documented membership of farmer-based organization and trainings received by farmers as factors that contribute significantly to intensity of adoption of improved rice variety. In another study, Chuchird *et al.* (2017) estimated the determinants of irrigation technologies among farmers in Chaiyaphum Province of Thailand. The results indicated that while membership of water user association had a significant and positive correlation with water

wheel irrigation technology, water user association and skill training had a negative and significant correlation with water pump irrigation technology. Simtowe *et al.* (2016) also estimated the determinants of adoption of improved pigeon pea under incomplete diffusion in Malawi. Their findings suggested that while distance to agricultural office had a negative relationship with adoption of improved pigeon pea, access to agricultural credit correlates positively with adoption of improved pigeon pea.

Similarly, factors influencing the intensity of adoption of improved highland maize variety in Toke Kutaye district, Oromia region, Ethiopia using Tobit regression model was studied by Milkias and Abdulahi (2018). The study revealed that while access to agricultural extension services and participation in training programmes had significant and negative influence on adoption, distance to the market had negative correlation with adoption. Moreover, Wiredu *et al.* (2015) using Cragg's double hurdle model to identify the key determinants of fertilizer adoption concluded that participating in fertilizer subsidy programme is critical in boosting the probability of adoption. A similar study with regard to fertilizer subsidy programme among smallholder farmers in Zambia was conducted by Mason *et al.* (2013).

3.5 The concept of Impact Evaluation

Empirical evidence in many research documents has suggested that the impact of farm intervention programmes have been magnificent (Ndoro *et al.,* 2014; Bezu *et al.,* 2014; Khonje *et al.,* 2015; Danso-Abbeam *et al.,* 2018). Assessing the impact of such intervention programmes on livelihood outcomes such as productivity, incomes, food and nutrition security, using non-experimental or observational data can be taken for granted. This is

because of the significance of finding the counterfactual impacts of the programme (Asfaw *et al.,* 2012; Khonje *et al.,* 2015). In observational data, the outcome variable for programme participants, if they had not participated cannot be observed. This problem of counterfactual scenarios can only be directly associated with experimental data. In experimental data, the treatment is assigned randomly to the target group, while another group serves as a control or untreated. This is to ensure that the potential outcome variable observed in the treatment group without treatment is a statistical representation of what would have happened with treatment (Shiferaw *et al.,* 2014; Amare *et al.,* 2012). Nevertheless, participation in an intervention cannot be done randomly because it is the voluntary decision of the farmers to participate or not based on the evaluation of the programme. Thus, farm households who decide to participate in the intervention programme and those who decide not to participate may be systematically different (Amare *et al.,* 2012).

Now, assuming the potential outcome variable of interest, output of farmers (Y_i) is a linear function with vector of covariates such as demographic characteristics, policy variables, to estimate the impact of an intervention programme on the output variable, we include the programme variable denoting one (1) for those who participated and zero (0) for those who did not as an explanatory variable and apply OLS estimator.

However, this approach cannot be relied on to produce unbiased and consistent estimates because of three fundamental flaws, namely; self-selection bias, endogeneity and missing data. Self-selection bias arises because of the voluntary nature of the treatment. Households self-select themselves into the programme and their decisions may be based on some characteristics. Thus, participants of the programme may possess different characteristics

from the non-participants (Amare *et al.*, 2012). For instance, households may participate in the programme due to their possession of some productive resources or the programme itself may target some farm households with some specific characteristics. This problem of self-selection bias contributes to the challenges of evaluating the impact of an intervention on potential outcome variable in observational data (Shiferaw *et al.*, 2014). To accurately estimate the magnitude of the effects of any programme, the treatment should be randomly assigned such that the only difference between them is the treatment status (Danso-Abbeam and Baiyegunhi, 2018).

Moreover, some characteristics that may influence farmers' decision to participate in the programme may also have the potential to affect the outcome variable of interest. Thus, the error term of the treatment status and that of the outcome variable may correlate, leading to endogeneity (Teklewood *et al*., 2013). These factors that affect farmers' decision status and the outcome variable of interest may come from observed and unobserved covariates (motivation, values, managerial skill, etc.). There is also a problem of missing data for the counterfactual outcomes due to the fact that the variable of interest can only be observed one state at a time (Wooldridge, 2003). Thus, only the potential outcome of the participants can be observed but the potential outcome had they not participated cannot be observed (i.e. the counterfactual scenario).

3.5.1 Impact evaluation techniques in agricultural intervention programmes

In evaluating the impact of agricultural intervention programme or adoption of an improved technology, many studies have used regression models like Heckman treatment effects, Tobit, double-hurdle correlated random effects and fixed effects models (Smale and Mason 2014; Ehiakpor *et al.*, 2016; Baiyegunhi *et al.*, 2018; Danso-Abbeam *et al.*,

2018). The challenge with these models is that though they are able to correct for selection biases and endogeneity, they lack the capacity to predict the counterfactual outcomes. The main econometric models to deal with the three key issues of impact evaluation in cross-sectional data is Propensity Score, Generalized Propensity Score, Endogenous Switching Regression, and Condition Mixed-process (CMP). The propensity score matching (PSM) is a non-parametric approach that uses matching technique to match treated against the control group based on observed characteristics. Endogenous Switching Regression uses instrumental variable approach where valid instrumental variables are used to identify the equation. PSM accounts for only observed characteristics while ESR accounts for both observed and unobserved characteristics. The PSM and IV methods are the two prominent techniques usually found in literature.

3.5.1.1 Propensity Score Matching technique

One of the widely used techniques in measuring the impact of agrarian intervention programme or innovation on an outcome variable of interest is the PSM. The PSM is a non-parametric estimation approach that does not require specification of any functional form and a random error term distribution. This estimation approach is theoretically appealing because it enables the comparison of the impacts of a treatment on the potential outcome of the treated and the control group (Heckman and Vytlacil 2005; Amare *et al.*, 2012). The fundamental principles of the PSM is to match the treated group against the control with regard to a predicted propensity of being treated conditioned on some observed covariates (Rosenbaum and Rubin 1983; Wooldridge 2003; Heckman and Vytlacil, 2005).

There are two critical assumptions underlying the estimation of impact using the PSM. The first assumption is the Conditional Independence Assumption (CIA). According to the

CIA, the decision to be treated is a random condition on some observed covariates (Abadie and Imben, 2006; Takahashi and Barrett, 2013). Thus, given some observed characteristics of the respondents, the potential outcome and the treatment status in the absence of treatment are statistically independent (Takahashi and Barrett, 2013). The second most important assumption in PSM is the Common Support Assumption (CSA). The CSA states that there should be a considerable similarity in observed characteristics between programme participants and non-participants. Thus, respondents being compared have equal probability of belonging to the treated and the control group (Amare *et al.,* 2012; Takahashi and Barret, 2013). If these two assumptions are met, then the magnitudes of the effects of the treatment on the treated called the average treatment effects on the treated (*ATT*) can be validly estimated (Smith *et al.,* 2005; Wossen *et al.,* 2015). The *ATT* can be defined as the differences in the mean of the potential outcome of the treated group with and without treatment defined within the region of common support. The PSM technique follows a two-step estimation procedure. First, the treatment variable is modelled as a choice dependent variable using probit or logit after which the propensity for each observation is calculated. Second, each treated sample is matched with non-treated sample with same or similar propensity score value and the *ATT* are estimated (Abadie and Imbens, 2006). One drawback of the PSM is that it cannot account for hidden biases, it can only correct for observed heterogeneity to the extent that they are accurately estimated (Oduol *et al.,* 2011; Amare *et al.,* 2012).

3.5.1.2 The Instrumental Variable Approach – Endogenous Switching Regression (ESR)

Another econometric technique that is designed to deal with the problem of observed and unobserved biases, endogeneity and missing data of the counterfactuals is the instrumental variable approach, specifically the endogenous switching regression (ESR). This Instrumental Variable (IV) has been used over the years to estimate the treatment effects of intervention programmes or agricultural technology adoption (Imbens and Angrist, 1994; Abadie, 2003; Abadie and Imbens, 2006). The IV approach usually requires a functional form and distributional error term (Abadie and Imbens, 2006). The fundamental assumption underlying the IV approach is that there must be at least an instrument that significantly affects the treatment status but not significant in explaining the potential outcome(s). In the IV framework, the techniques to estimate the average treatment effects include the Local Average Treatment Effect (LATE) and the latest econometric technique known as the Endogenous Switching Regression (ESR) technique.

Local average treatment effects (LATE) requires that minor restrictions are imposed by a wide range of models and economic circumstances. That is, to estimate LATE, making assumptions about the distribution of the outcome variable or assume that the treatment effect is constant may not be necessary (Oduol *et al.*, 2011). As a result, if there is/are no available control group(s), the average treat effects on the target population can still be estimated (Oduol *et al.*, 2011).

Another econometric challenge in measuring impact is the use of treated samples and the control samples. The ultimate question is whether treatment should be assumed to exhibit an average causal effect across the whole population samples as proposed by the traditional instrumental variable approach such as Heckman Treatment Effects and the, Two-Stage

Least Square (2SLS). Thus, should participation in USAID-ADVANCE be assumed to affect the outcome variable by way of intercept shift or by way of the shift of the slope as noted by Alene and Manyong (2007). When estimation is done by way of pooled sample, then the assumption is that the sample characteristics have similar causal effects (common coefficient) on both treated and control groups. This suggests that participation in an intervention programme will have an intercept shift effects, and will always be the same, regardless of the covariates determining the value of the potential outcome (Alene and Manyong, 2007). Nevertheless, in many empirical studies, this may not be the case (Teklewood *et al.*, 2013b; Shiferaw *et al.*, 2014). This situation instigates the use of ESR to deal with the problem of intercept shift. In ESR analysis, separate equations are specified for both treated and the control groups, while accounting for endogeneity that may arise from sample selection bias. The ESR hypothesizes that factors of production are likely to have different impacts on the outcome variable of interest (Shiferaw *et al.*, 2014). The ESR also permits interactions between treatment status and other explanatory variables in the outcome equation.

3.5.1.3 Conditional (Recursive) Mixed-Process (CMP)

Roodman (2011) recently developed the CMP framework to handle joint estimation of two or more models that are likely to have their error terms being correlated. The CMP is a framework of multi-equation system where the dependent variable of each equation may have different format, where the error components of the equations may or may not exhibit any correlations. Thus, equations in CMP system are assumed to be independent of each other but have correlated error terms (Roodman, 2011). Baum (2016) indicated that CMP is built from the fundamental assumption of seemingly unrelated regression (SUR).

Moreover, the CMP has the capacity to estimate the system of equations without considering the continuous dependent variable assumption in the classical regression models. Thus, different equations can have different types of responses. The dependent variable can be in the form of binary response (logit or probit), ordered (logit or probit), categorical (multinomial logit or probit), censored (Tobit), truncated, interval regressions, etc. (Roodman, 2011).

One unique feature about the CMP is its property of dealing with simultaneity and endogeneity while providing consistent estimates (Asfaw and Lipper, 2015). The CMP framework provides recursive systems of equations where all potential endogenous variables are on the right-hand side of the equations (Asfaw and Lipper, 2015). It also has the ability to correct for sample selection bias that may emanate from unobserved characteristics (Makate *et al.,* 2016). In estimating within the framework of CMP, the dependent variable of the first equation can also be an independent variable of the second equation (Baum, 2016). Another extraordinary property of CMP is that it provides excessive plasticity in model building. For example, a continuous dependent variable can be regressed with many potentially endogenous explanatory variables with different response types (e.g. censored and categorical), while each variable may have an instrument. It also permits models estimations to have over-lapping and non-overlapping sample units (Baum, 2016). Moreover, the traditional IV estimators such as Heckman two-step models, two-stage least squares (2SLS), among others can be estimated within the framework of CMP to produce estimates that are consistent and unbiased.

3.5.2 Endogenous Treatment for Count Data Models

Sometimes, there are situations in econometrics in which one wants to estimate the effects of a potential dichotomous treatment on an outcome variable of interest which is count in nature (count data). This is very rare in agricultural literature but common in health economics. For instance, the effects of physician advice on the number of cigarettes smoked per month (Kenkel and Terza, 2001) and the effects of having health insurance on the number of hospital visits (Riphahn *et al.,* 2003). In the agricultural context, we may be interested in the effects of programme participation on the number of technologies adopted. In all these situations, participation may be potentially endogenous. Participating in an intervention that trained farmers on number of production and marketing strategies cannot be exogenous. This is because farmers who had wrong perception about intervention programmes will not participate and, hence, will not adopt any of the components within the package.

The effects of participation on the outcome variable of interest (in this case the number of technologies and marketing strategies adopted) may also have sample selection issue. For instance, in a sample of participants, data on intensity of participation may not be reported by all farm households and may not be missing at random with respect to the intensity of participation. In such circumstances, ignoring sample selection will result in inconsistent and biased estimates of the treatment status (participation) leading to wrong policy conclusions. Analyzing the impact of treatment variable of interest on outcome variable which takes the form of count data has been very rare in agricultural economics literature. This study, uses endogenous treatment effects with count data outcome to evaluate the impact of participating in USAID-ADVANCE intervention programme on the intensity of

participation. The intensity of participation is conceptually defined as the number of production technologies and the marketing strategies adopted by individual farm households.

3.6 Empirical Evidence of Impact Evaluation

Many empirical studies have shown that agricultural intervention programme and innovations have contributed significantly to increased production and farm-level efficiencies, improved incomes and overall wellbeing of the farm households. Danso-Abbeam *et al.* (2018) used Heckman treatment effects model, regression on covariates, and regression on propensity scores to evaluate the effect of agricultural extension programmes on farm productivity and income of farmers in Northern Ghana. The empirical findings showed positive and statistically significant causal effect of extension programmes delivered by ACDEP on farm productivity and incomes. A similar study conducted by Baiyegunhi *et al.,* (2018) on the impact of outsourced extension programme on farmers' net farm income using PSM indicated a positive and significant farm income gain from the programme. In other studies, Wosen *et al.* (2017) empirically estimated the impact of cooperative membership on farm technology adoption and welfare using propensity score techniques, specifically Inverse-probability-weighted Regression (IPWRA). The empirical findings indicated that being a member of cooperative society had a positive and significant impact on adoption of farm technology and household welfare (proxy as consumption per capita). Gebrehiwot (2015) analyzed the impact of agricultural extension programmes on households' welfare using farm-level data from Ethiopia. The author applied propensity score matching and regression on covariates in welfare impacts of extension programmes

with welfare proxied by household income, household income diversification index, livestock investment, and fixed asset investment. The results indicated a significant improvement in household income, fixed asset and investment as a result of participation in the extension programme. However, there was a very marginal impact of the extension programme on diversification index.

Mwansakilwa *et al.* (2017) employed propensity score matching approach to estimate economic impact of Village Savings and Loan Association (VSLA) on welfare of farm households using farm-level data from Eastern and Western Zambia. In their analysis, welfare was conceptualized as farm household's total consumption expenditure and consumption expenditure per capita. The results indicated that about 38% and 17% of household total consumption and consumption per capita per week can be ascribed to VSLA intervention programme. In evaluating the impact of value chain programmes (contract farming and marketing cooperatives) on the farm incomes of farmers in Tigray, Northern Ethiopia, Alemu *et al*. (2016) applied PSM technique complemented with regression on covariates. Their results emphasized the significance of contract farming in improving the income levels of farm households. However, the study found no empirical evidence of marketing cooperatives contributing to farm income levels of the sampled farm households.

Moreover, the causal effects of adoption of modern varieties of wheat was estimated with PSM by Coromaldi *et al.* (2015) using data from Uganda. From their empirical findings, farm households who did not adopt the improved varieties of wheat were better off compared with the adopters of the modern varieties of the crop. That is, adopters would have had 12% and 11% of food consumption per capita and profit, respectively had they

not adopted. These surprising findings, according to the study, could be attributed to the marginalized and climate prone areas where adopters found themselves. Similarly, Shiferaw *et al.* (2014) employed endogenous regression complemented with propensity score matching to analyze the impact of improved wheat variety on farmers' food security status in Ethiopia. The two econometric techniques produced consistent results suggesting that the use of improved variety of wheat improves the food security status of the farm households. That is, adopters were found to be better off because of adoption and the non-adopters would have been more food secured had they adopted.

Another study in African cocoa industry in Ghana, Nigeria, and Cote d'Ivoire, Tsiboe *et al.* (2016) measured the welfare impacts of cocoa livelihoods programme phase I (CLP-I) using data from the period of pre (2009/2010) and post (2012/13) cocoa season. The key findings from the study did indicate that there were 62%, 50%, 34% and 32% increase in the yields of Cameroun, Nigeria, Cote d'Ivoire, and Ghana, respectively as a result of the programme.

3.7 Key issues arising from literature review

So far, pieces of theoretical literature indicate the concept of adoption, measurement of adoption and the techniques for estimating the impact of an intervention programme on farmers' welfare. Empirically, lots of studies have been conducted with regards to the areas of a technology or a simultaneous adoption of several farm practices as well as the impact of technology adoption or programme intervention on the livelihoods of rural farm households. However, studies on the following, which are the objectives of the study are rare in the Ghanaian agricultural literature: (1) the drivers of participation in the ADVANCE intervention programme, (2) intensity of the adoption of components of the

ADVANCE package, and (3) the impact of the programme on the welfare of the beneficiaries. Hence, guided by the theoretical and the empirical literature reviewed, the study hopes to fill this gap in the literature.

Besides, the design and implementation of policies and intervention programmes in recent times have been informed by the "theory of change" which guides the attainment of the intervention's outcomes of interest. The 'theory of change' outlines the route to the ultimate goal of the programme. It spells out the principles as to the "why and how" the intervention should be implemented with its intended results. It allows for remedial measures to be taken with respect to the systems put in place in arriving at the expected results by the participants. The conceptual framework of this research, therefore, hinges on the theory of change of the USAID/ADVANCE project.

Agricultural household models also recognize farm households in developing countries as being semi-commercial hence involved the production, consumption and supply of all or part of the farm labour. The agricultural household model is relevant as the effect of the intervention programme on beneficiaries as well as that on non-beneficiaries, and non-agricultural households would be considered in realizing the full impact of the intervention programme.

The concept of adoption of farm technologies is defined as the integration of new technologies into an already existing one with the process preceded by periods of trials to facilitate adoption by the target group. The study thus considers adoption as the use of at least one of the GAPs and marketing strategies by a farmer within the project life cycle. Some of the technologies were adopted as substitutes to others and some as compliments.

This is often accompanied by simultaneous diffusion and adoption by farmers to complete the package.

Given the reviewed literature, the MVP is the most appropriate model to be employed in examining the determinants of the adoption of the GAPS and marketing strategies. The MVP can handle the simultaneous adoption decisions of a farmer and assumes that the adoption of a component in the package depends on the adoption of other components already adopted. It allows the relationship between the adoption of different technologies to be established as well as the potential correlations between the error terms (Ahmed, 2015). The Poisson regression was used to analyzed the intensity of adoption. This is because the dependent variable (intensity of adoption) is a numerical count by its nature (Cameron and Trivedi, 1990) and discussed by Greene (2008). Once there is a random occurrence of the number of components in the package used by the farmer, the appropriate probability distribution is the Poisson distribution. The PSM, a non-parametric estimation approach that does not require specification of any functional form and a random error term distribution was used in estimating the impact of the intervention programme. It matches the treated group against the control with regards to a predicted propensity of being treated conditioned on some observed covariates. Once the two critical assumptions of CIA and CSA are met, then the magnitudes of the effects of the treatment on the treated called the average treatment effects on the treated (*ATT*) can be validly estimated. The *rbounds* test was used to examine the possibility of the presence of unobserved confounders that is likely to biased the estimates from the PSM.

CHAPTER FOUR

4.0 METHODOLOGY

4.1 Introduction

In this chapter, the methods used in achieving the objectives outlined in chapter one (section 1.4) are discussed. The chapter starts with the description of the study area followed by the conceptual and then the analytical framework of the study. The sampling techniques, the type and sources of data collected are also explained in this chapter. Finally, the econometric techniques for measuring the objectives are explained.

4.2 Study area

This study was conducted in the three (former) northern regions of Ghana namely; Upper East, Northern and Upper West Regions which have now been re-demarcated to include two additional regions namely Savanna and North East Region (Fig 4.1). Ghana is a tropical country located in the West African coastline and shares boundary with Togo to the east, Cote d'Ivoire to the west, Burkina Faso to the north and the southern part of Ghana is occupied by the Gulf of Guinea. Ghana currently has sixteen administrative regions with total land area of about 238,533km^2. The capital city, Accra is located in the Greater Accra region which is the smallest region in terms of land size.

These regions cover total land area of 95, 000km^2 with an estimated population of 4,228,116 (GSS, 2012). These regions were selected due to their high level of rice, maize and soybean production and also because they are the catchment area of the USAID-ADVANCE intervention programme for value chain (VC) development. Agriculture is the most important economic activity in these three (former) northern regions. Majority of

the farmers in the study area cultivate at least one of these crops: maize, rice and soybean. The climatic conditions for the regions are suitable for the production of the selected crops. The climate is relatively dry with a single rainy season that usually starts from May and ends in October. Total amount of rainfall ranges between 750 millimeters to 1,050 millimeters per annum. The dry season starts in November and ends in March/April thereabout with very high temperature towards March/April and low temperatures observed in December/January. The three northern regions (former) are the poorest and the least developed in Ghana. The mainstay of the people is agriculture, therefore, majority of the economically viable people are engaged in agriculture (MoFA, 2016). Farmers in these regions have benefited from a lot of interventions programmes aimed at increasing their farm yield hence livelihood. These programmes and projects have introduced farmers to innovations so as to improve their productivity yet farmers continue experience yields far below the achievable yield due to a number of challenges. Access to markets has also be herculean task for farmers which compels them to sale their produce at farm-gate prices.

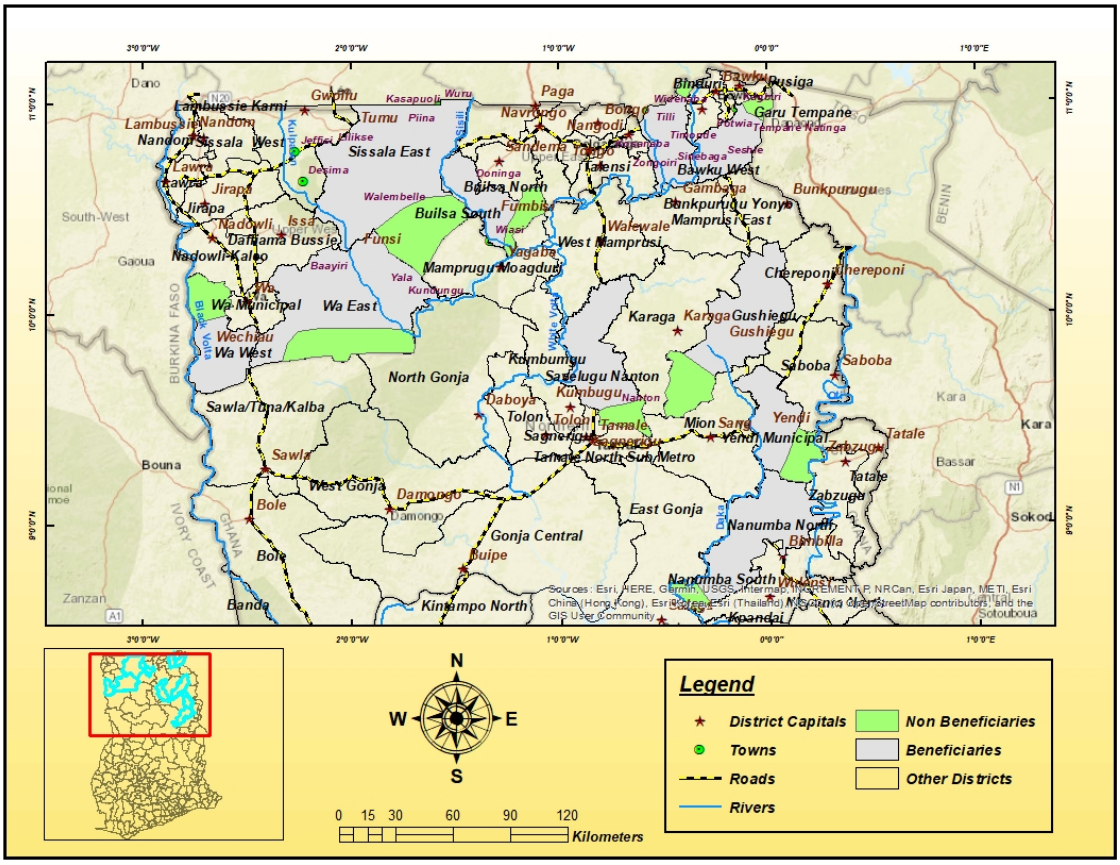

Figure 4.1: Map of the Study Area

4.3 Population sampling and data collection techniques

The study used two main techniques to collect survey data: questionnaire administration and interview with key informants. This is to help triangulate the information gathered. Data for the study is completely primary. The survey employed a multistage sampling technique in selecting the respondents. In the first stage, three agricultural districts each from Upper West and Upper East and four from Northern regions were purposively selected from a list of districts with relatively large share in the production of rice, maize and soybean in the three regions. The choice of the three districts was based on the combined production levels of rice, maize and soybean of these districts. The purposive

selection was done in consultation with the various district offices of MoFA and staff of ACDEP as well as a local facilitator of the USAID-ADVANCE intervention programme. In the second stage, stratified sampling was used to divide the districts into two (2) strata, one stratum making up USAID-ADVANCE communities and the other stratum non-USAID-ADVANCE communities. Three communities each for USAID-ADVANCE operational areas/communities and two for non-USAID-ADVANCE operational communities were randomly selected. More USAID/ADVANCE communities were selected so as to compare the effects of the intervention programme on participants across the former three northern regions. In each community, USAID-ADVANCE beneficiaries were identified by obtaining a list of participants from USAID-ADVANCE office in Tamale. Simple random sampling was employed to select seven to fourteen respondents from each of these USAID-ADVANCE communities and non-USAID-ADVANCE community. In total, 673 respondents were surveyed, comprising 394 USAID-ADVANCE farmers and 279 non- USAID-ADVANCE farm households. Figure 4.1 and table 4.1 show respectively, the map indicating the locations of the study area and number of districts, communities, and farmers selected for the three commodities under study (rice, maize, and soybean).

The data were collected through a household survey using semi-structured questionnaire aided by face to face interview of rice, maize and soybean farm households. The questionnaire was designed to collect a range of data on levels of rice, maize and soybean production, household socioeconomic characteristics, family assets, farm-specific characteristics, social capital and policy and institutional variables likely to influence farming operations in the study areas. Research assistants from the Nyankpala Campus of

the University for Development Studies were used as enumerators for the collection of data. These people have prior experience in survey work. Key informants such as heads of departments of ACDEP and ADVANCE and community leaders were approached to discuss challenges and opportunities relating to the productivity of the three crops.

In determining the sample size for the study, Slovin's formula used by Rivera (2007) was employed. It is expressed as:

$$n = \frac{N}{(1 + Ne^2)}$$

Where *n* is the sample size to be used for the study or number of farmers to be included in the study, *N* is the population size (number of potential maize, rice and soybean farmers in northern Ghana) and *e* is the margin of error. This study used 5% as the margin of error.

According to GSS (2010) the number of crop farming households in the former Northern, Upper East and Upper West regions are 230,452; 143,800 and 81,251 respectively with corresponding household sizes of 7.7, 5.8 and 6.2. Maize, rice and soybean are the most staple crops in Ghana and predominantly cultivated in the three former northern regions (Martey *et al.*, 2012; MoFA, 2016). The total number of maize, rice and soy farmers in the northern region is therefore 1,774,480 (230452x7.7), 834,040 (143x5.8) in the Upper East and 503,756 (81251 x6.2) in the Upper West. These gives a total farmer population of maize, rice and soy to be 3112276. From Slovin's formula,

$$n = \frac{3112276}{1+3112276\ x\ 0.05^2} = 399$$

Although the sample size, n is approximately 400, data was collected from 700 respondents which was cleaned to arrive at 673 for the analysis. Table 4.1 shows the distribution of respondents.

Table 4.1: Distribution of respondents across study area

Region	Number of Districts	ADVANCE Communities		Non-ADVANCE Communities		Pooled
		No. of C'ties	No. of Farmers	No. of C'ties	No. of Farmers	
UWR	3	9	117	6	84	201
UER	3	9	117	6	84	201
NR	4	12	160	8	111	271
Total	**10**	**30**	**394**	**20**	**279**	**673**

Before the administration of the main questionnaire, pre-testing was done in two (one intervention and non-intervention) communities in one district from each region. In each community, five respondents were randomly selected making a total sample size of 30 respondents[3]. These communities are not part of those selected for the main survey. However, they have very similar characteristics with the latter with respect to intervention beneficiaries and non-beneficiaries. The pre-tested questionnaire was well-examined and some modifications were made accordingly. The data from the pre-tested questionnaire was analyzed and the reliability coefficient tested. The reliability coefficient obtained was 0.86 indicating that the survey instrument was good and could be used for the study.

[3] Though the unit of analysis is households, respondents and households are used interchangeably.

4.4 The concept of the Study

This research work is grounded on the theory of change that spells out the principles, assumptions and the logic that connects an intervention programme like ADVANCE or service seeks to achieve and *why and how* it carries out its activities as well as its intended benefits (results). Some scholars like Rogers (2008) described this as "programme theory". The theory of change is a formal and explicit articulation of assumptions that underlines the rationale and design of an intervention programme. It explains why it is prudent to expect that the intervention could achieve a change of service for the beneficiaries. It is helpful to visualize the theory of change as a "pathway to change" along which beneficiaries of the ADVANCE programme "travel", moving from their initial stages laden with problems and needs to their outcomes that the intervention programme sought to achieve (Ghate, 2016; Hawe, 2015). The term *logic model* (sometimes confusedly used interchangeably with theory of change*)* according to Hawe, (2015) is a pictorial representation of theory of change in its short form or diagrammatically as an output or process of the theory of change (Refer Fig 4.2).

The low productivity and competitiveness of the selected commodities (maize, rice and soybean) and lack of market access by smallholder farmers in the three northern regions of Ghana could be ascribed to some antecedent or root causes such as extensive poverty, poor soil fertility and policy variables such as inadequate extension delivery to farmers, limited availability of credit etc. Solutions to the challenges of low productivity and competiveness as well as limited market access can be remedied through provision of resources by ADVANCE in the form of trainings i.e. farm management and market access practices.

The ADVANCE value chain (VC) programme package which consist of farmers' participation and adoption of the package, would impact on the welfare of the beneficiaries. Consumption per capita, household income and farm income per acre have been proxied as welfare indicators. Conceptually, it is expected that farmers who participated in the USAID-ADVANCE VC development programme would achieve higher output level and obtain greater impact than non-participants largely as a result of ADVANCE activities (content of training curriculum, specific messages to be transmitted or taught, methodology etc. Expected higher outputs to be achieved by participants would be triggered by ADVANCE resources in form of infrastructure necessary to deliver the content (type, number of competent staff, trainings required, equipment and facilities, ancillary services, and dosage). It is theorized that individual or collective participation in any agricultural intervention programme is largely a behavioral choice at a particular time and space. Thus, some farmers may decide to participate when they are aware of the programme and its advantages over costs/disadvantages, whereas others may choose not to participate despite being aware of the programme and its benefits over costs/disadvantages. In the agricultural literature, participation in an intervention programme is hypothesized to be affected by socioeconomic/household characteristics, household assets, social networking or institutional factors (Amare *et al.*, 2012; Shiferaw *et al.*, 2014; Awotide *et al.*, 2016). The schematic presentation of the conceptual framework is presented in Figure 4.2

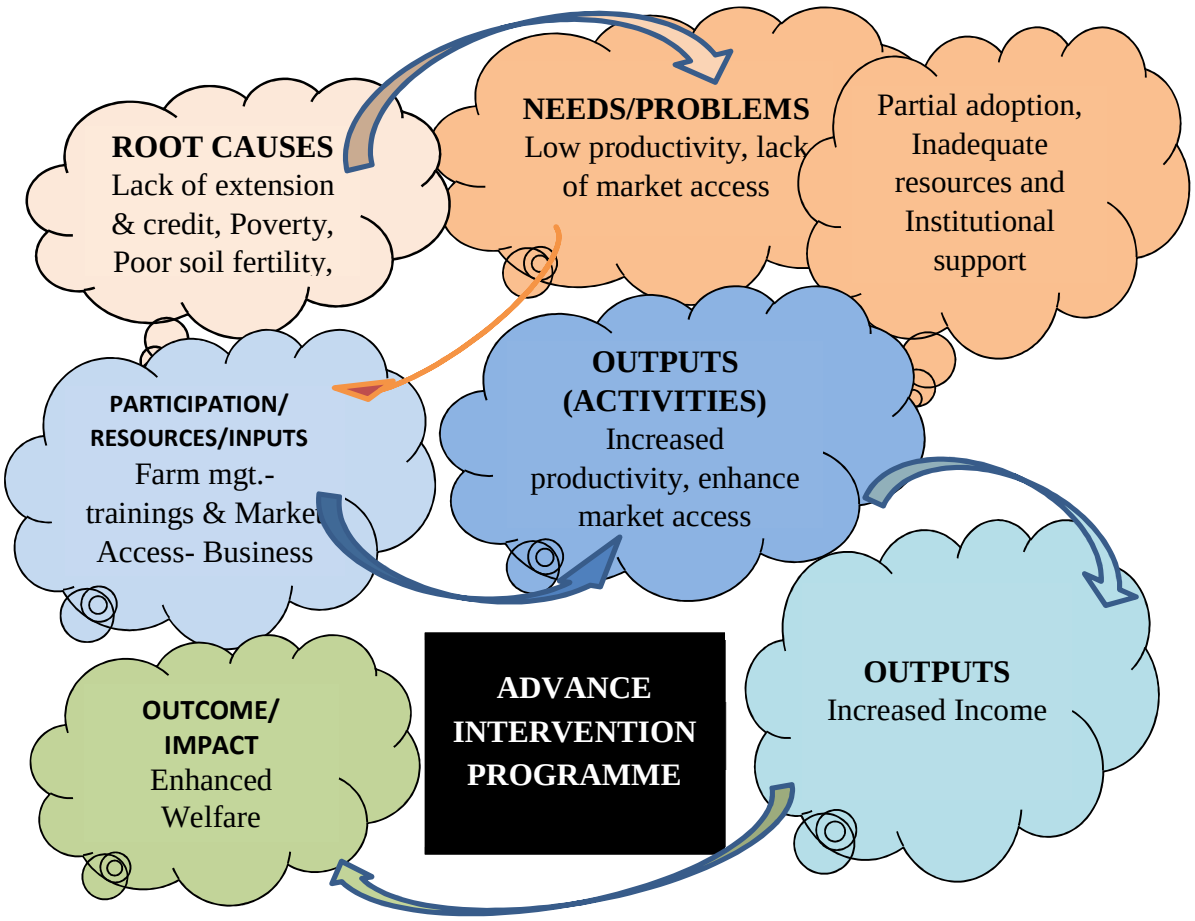

Figure 4.2: Conceptual Framework of Farmers' Participation in VC Programme and Impact

From Fig. 4.2, farmers' decision to participate in the USAID-ADVANCE value chain development programme depends on socioeconomic, institutional, and farm-level specific factors. Some of the socioeconomic factors include the age of the farmer, educational attainment, household size, and sex of the farmer. Farm-level characteristics include farm size, resources and others, while institutional and policy variables may be comprised of access to credit, membership to farmer-based organizations, access to extension services, and market access. These factors are expected to play a significant role in influencing a

farmers' decision to participate in the USAID-ADVANCE VC development programme and hence to adopt the intervention package.

This study assumes a relationship between the probability of adoption and the extent of adoption of intervention packages through the decision of the farmer to participate in the VC programme. Hence, the likelihood and the extent or intensity of USAID-ADVANCE value chain adoption are likely to be influenced by similar factors. The hypothesis is that the probability of participation, and hence the extent/intensity of adoption of the USAID-ADVANCE VC intervention package are influenced by the set of socio- economic, farm level and institutional/ policy factors mentioned above.

The study classifies the USAID-ADVANCE VC intervention package into two main groups namely, GAPs and market access components. The GAPs components include planting in rows, use of certified seeds, and fertilizer application. Market access components include grading (weighing and sorting), labelling of bags and collective marketing. The concept of the study postulates that a farmer's participation in the USAID-ADVANCE VC intervention programme and adoption of the GAPs and market access components will lead to improvement in the farmer's productivity and income earnings. These outcomes will, in turn, result in the farmer's welfare *ceteris paribus*. The study uses farm income per acre, total household income and household consumption expenditures per capita as measures of household welfare (see Figure 4.2).

4.5 Analytical Framework and Empirical Models

The study used descriptive analytical techniques to quantify the extent of adoption of the two major components of the USAID-ADVANCE VC programme. For inferential analysis, the study employs econometric techniques such as Multivariate Probit Model, Count Data Regression (Poisson Model), Propensity Score Matching, and Endogenous Treatment Effect with Count Outcome.

The theory of adoption of an agricultural intervention programme or farm technology package has over the years provided the foundation for research work on farmers' attitudes towards joining farm intervention programmes (Rogers, 1983; Toborn, 2011). Farmers who may decide to join the programme may adopt some or all the components of the programme. For instance, farmers who participate in the USAID-ADVANCE intervention programme may adopt two of the GAPs components out of the package. The adoption decision may depend on farmers' demographic characteristics and institutional factors as indicated in the conceptual framework (Amare *et al.*, 2012; Shiferaw *et al.*, 2014; Awotide *et al.*, 2016). As noted earlier, the rate of adoption is the relative speed with which farm technology is adopted by a farmer, whereas the intensity is the degree of use (Rogers, 1983). The rates and intensities of adoption of technological packages are influenced by the perception of farmers on the benefits of improved technology against alternatives (Toborn, 2011).

Following Khonje *et al.* (2015), Becerril and Abdulai (2010) and Crost *et al.* (2007), the observed outcome of adoption of an improved farm technology can be modelled under the framework of a random utility function. Consider the i^{th} farm household facing a decision on whether or not to participate in an intervention programme or adopt a given technology.

Let $P^{\bullet}$ denote the difference between the benefit the farm household derives from adopting USAID-ADVANCE GAP and market access packages (U_{iA}) and benefit from non-adoption of the package (U_{iO}). The farm household will adopt the package if

$$P^{\bullet} = U_{iA} - U_{io} > 0 \quad [1]$$

The net benefit $P^{\bullet}$ is unobservable and can be expressed as a function of observed characteristics (Z_i) and error term (ε_i) as follows;

$$P_i^* = Z_i\beta + \varepsilon_i \text{; with } P_i = 1 \text{ if } P_i^* > 0 \text{ and } P_i^* = 0 \text{, otherwise} \quad [2]$$

where P is a dummy variable representing the adoption of individual components of the package; $P = 1$ if VC is adopted and $P = 0$ if otherwise. Z_i is a vector denoting household demographic characteristics, household assets and institutional/policy variables, β is a vector of parameters to be estimated and ε_i is an error term.

The following sections give a brief description of the empirical models that were used in analysing the adoption of the various components of the GAPs and marketing strategies, intensity of adoption, and impact of the intervention programme on the welfare of its intended beneficiaries.

4.5.1 Multivariate probit model (MVP)

Considering that farmers participating in the USAID-ADVANCE programme may have more than two GAPs and market strategies components to adopt, the Multivariate Probit Model (MVP) is employed here to model the simultaneous adoption decisions of the GAPs and marketing strategies. The MVP is used when there is an assumption that the farmer's decision to adopt a component of a given package depends on the adoption of other

components already adopted. For instance, in this study, we assume that farmers' decision to apply fertilizer may depend (though not necessarily) on the fact that they have adopted certified seeds or row planting. The MVP estimation technique uses a Probit Model to examine the relationship between each of the components of the VC package and farmers' socioeconomic, farm-specific and institutional factors. In this study, since we have six selected GAPs and marketing strategies, we have six adoption equations forming a system of equations. All these six are estimated simultaneously, hence, the name 'Multivariate Probit Model'. It also examines the correlation among the components of the VC package. The correlation may emanate from the same unobserved characteristics of farmers that have the probability of influencing adoption of different practices. The correlation is based on the principle that adoption of one GAP technology may depend on another complementary technology (positive correlation), or may be influenced by an available set of substitutes (negative correlation) (Ahmed, 2015).

Following Ahmed (2015) and considering the selected components of GAPs and marketing strategies adopted by the farmers, each adoption equation can be specified as;

$$Y_{ik} = \beta_k X_{ik} + \varepsilon_i \qquad (k = A, B, C, D, E, F) \qquad [3]$$

where Y_{ik} is the latent dependent variable representing net benefits derived from the adoption, X_{ik} denotes the observed farmer household and farm-specific characteristics, as well as institutional and policy variables. Note that *A, B, C, D, E, F* represent the selected GAPs practices (certified seeds, row planting and fertilizer application) and the selected marketing practices (labelling, grading and collective marketing), respectively. In the

second system of equations, the unobserved preferences in equation [3] translate into an observable dichotomous outcome which can be specified as;

$$Y_{ik} = \begin{cases} 1 \; if \; Y_{ik}^{*} > 0 \\ 0 \; otherwise \end{cases} \qquad (k = A, B, C, D, E, F) \qquad [4]$$

In the MVP framework, where several simultaneous adoptions of GAPs and marketing strategies are allowed, the error terms jointly follow a multivariate normal distribution with zero conditional mean and variance normalized to unity. Where

$(u_A, u_B, u_C, u_D, u_E, u_F) \approx MVN(0, \Omega)$ and the symmetric variance-covariance matrix Ω can be specified as;

$$\Omega = \begin{bmatrix} 1 & \rho AB & \rho AC & \rho AD & \rho AE & \rho AF \\ \rho BA & 1 & \rho BC & \rho BD & \rho BE & \rho BF \\ \rho CA & \rho CB & 1 & \rho CD & \rho CE & \rho CF \\ \rho DA & \rho DB & \rho DC & 1 & \rho DE & \rho DF \\ \rho EA & \rho EB & \rho EC & \rho ED & 1 & \rho EF \\ \rho FA & \rho FB & \rho FC & \rho FD & \rho FE & 1 \end{bmatrix} \pm \qquad [5]$$

Where $\rho(rho)$ represents the pairwise correlation coefficient between any two components of the package. For instance, ρAB represents the correlation coefficient between certified seeds and row planting. A positive value of ρAB implies the certified seeds and row planting are complementary. In other words, they are used together. The reverse is true for a negative coefficient value. When the error terms are correlated, then the off-diagonal elements in the variance-covariance matrix (Ω) of the adoption equation formulate into a non-zero form and as such, equation [4] becomes the general MVP model.

Following from the foregoing and especially using equation [3], the empirical function/ model for the adoption of the GAP and marketing strategy components in the USAID/ADVANCE VC programme can be formulated as;

$$Y_{ik} = \beta_0 + \sum_{k=1}^{K} \beta_{ik} X_{ik} + \varepsilon_i \qquad [6]$$

Where, $\beta's$ are parameters to be estimated; X_i denotes socio-economic characteristics of the farmer, farm-specific variables, institutional and policy factors.

4.5.2 Count data regression – Poisson model

To analyze the factors influencing the intensity of adoption of GAPS and marketing strategies, the number of practices adopted by each individual farmer defines the dependent variable. As noted by Lorh and Park (2002) and Sharma *et al.*, (2010), the number of technologies adopted by an individual farmer is interpreted as a measure of intensity or diversity of adoption albeit some limitations and assumptions. A major limitation of the count data models is that they lack sound theoretical basis and that there is limited guidance on its most suitable functional form, although they are outstanding in its application in modelling number of technologies to be adopted. On its assumptions, it has been noted that once a farmer derives a greater utility from the last technology adopted, there would be no limit to the number of technologies to be adopted. Thus, it is assumed to be better adopting a greater number of practices where marginal benefit is at least equal to the marginal cost. The second assumption is that the adoption decision of a farm household for any of the practices does not preclude the adoption of other available technologies. Isgin *et. al.*, (2008), however, postulated that the adoption of a given technology might not be

exclusively independent of another since the effects of certain technologies adopted might be complementary. Following Cameron and Trivedi (1990) and discussed by Greene (2008), the number of GAPs and marketing strategies a farmer adopts could be modelled under the framework of Poisson regression analysis. This is because the dependent variable (intensity of adoption) is a numerical count by its nature. Given that there is a random occurrence of the number of components in the package used by the farmer, the appropriate probability distribution is the Poisson distribution. Count data model has been used in numerous studies to explain the intensity of adoption of various technologies (e.g., Nkegbe and Shankar, 2014; Sharma *et al.*, 2011; Isgin *et al.*, 2008; Rahelizatovo and Gillespie, 2004; Lohr and Park, 2002). The probability of adopting a number of components in the package at any given period, Y_i subject to farmer characteristics X_i can be modelled using the Poisson count data model (Cameron and Trivedi, 2010; Greene, 2008; Winkelman 2008) as;

$$\Pr(Y_i = Y_i / X_i) = \frac{\mathrm{I}^{-\lambda_i}\gamma_i^{Y_i}}{Y_i}, \gamma_i \in R^+, Y_i = 0,1,2,3... \quad [7]$$

From equation [7] above, the parameter $\gamma_i = E(Y_i / X_i) = Var(Y_i / X_i)$ and the mean is defined as $\gamma_i = \exp(X_i^{/}, \beta)$ where $X_i^{/}$ is a vector of household characteristics and β a vector of unknown parameter to be estimated.

Nevertheless, the basic Poisson regression although used mostly in literature suffers a shortcoming assuming that the variance of the count dependent variable and its conditional mean are equal. This situation is called the *equi-dispersion* assumption (Trivedi and Cameron, 1998; Winkleman 2008). However, in many count data analysis, equi-dispersion

is not tenable. Thus, the count dependent variable can potentially exhibit over-dispersion where the variance of the count dependent variable is greater than the conditional mean (Congdon, 2013). The presence of over-dispersion renders the fundamental assumption of the Poisson distribution of the error term weak. To account for the presence of over-dispersion, Negative Binomial was estimated. The Negative Binomial is a flexible count data model that allows the variance to differ from the conditional mean and provides a test of over-dispersion. The presence of over-dispersion biased the standard errors of the estimates (β) downwards, though still consistent (Grogger and Carson 1991). The general model for the negative binomial distribution can be expressed as;

$$f(y/\mu,\alpha)=\frac{\Gamma(y+\alpha^{-1})}{\Gamma(y+1)\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu}\right)^{\alpha^{-1}}\left(\frac{\mu}{\alpha^{-1}+\mu}\right)^{y} \quad [9]$$

where $\mu=\exp(x',\beta)$ $y=0,1,2,....$ [10]

$\alpha \geq$ defines the extent of over-dispersion, thus, the extent to which the variance differs from the mean. That is, the variance of the negative binomial is not equal to the mean. This condition can be expressed as;

$$v(y/x_i)=\mu+\alpha\mu^2 \quad [11]$$

The significance of the alpha coefficient (α) in the estimated negative binomial shows the presence of over-dispersion in the model. If the estimated alpha coefficient is greater than zero, then the conditional variance is greater than the conditional mean resulting in the presence of over-dispersion and therefore, the negative binomial fits the data better than the basic Poisson regression model. However, a zero value of alpha coefficient indicates

that the conditional mean and variance are equal, hence, the negative binomial reduces to the basic Poisson regression. Finally, the empirical model for estimating the count data model can be specified as;

$$\Pr(Y_i = y_i / x_i) = f(x_i) \quad [12]$$

Where Y_i represents the number of GAPs and marketing strategies (intensity of adoption) adopted by the farm households and x_i is a vector of variables explaining the intensity of adoption.

4.6 Overview of Impact Evaluation Framework

The introduction of intervention programmes, technology innovations and farmers' participation in output market have been documented to cause substantial changes to household performance and other welfare indicators such as consumption expenditure per capita, food security, poverty status, among others (Asfaw *et al.*, 2012; Bezu *et al.*, 2014; Shiferaw *et al.*, 2014; Danso-Abbeam and Baiyegunhi, 2018). A significant challenge in evaluating the impact of such intervention programmes or adoption of an innovation is to determine the counterfactual effects of the programme on the outcome of the beneficiaries (i.e. what happened if they did not participate in the programme or adopt the technology). For instance, what will be the level of household consumption expenditure per capita or poverty status if they had not participated in the programme? The welfare outcome of the programme participation had they not participated is what is called the *counterfactual effect.* The major challenge in every impact evaluation in a non-experimental study is to accurately construct this counterfactual effect. A well-accepted outline that serves as a

guide to analyze the counterfactual scenario is called the potential outcome framework or the Roy (1951) – Rubin (1974) model.

Under the Roy (1951) – Rubin (1974) model, every farm household has two potential outcomes; an outcome when individual decides to participate in the programme (treated) represented by Y_1 and an outcome when individual did not participate (control) represented by Y_0. If treatment or programme participation is defined as T, where ($T = 1$) indicates treatment or programme participation and ($T = 0$) represents the control group, then the difference between the two potential outcomes is the treatment or programme participation effects and can be expressed as $Y_i = T_{i1}Y_i + (1 - T_{i0})Y_{oi}$.

However, taking the difference between the two potential outcomes as the treatment effects has a major methodological challenge because of three related problems, namely, self-selection bias, endogeneity and the issue of missing data for the counterfactual (Wooldridge, 2003) as noted earlier. The decision to participate in the market or not is voluntary and an individual may self-select him or herself. Market participating households may have systematically different characteristics compared to households that did not participate given the information they have (Amare *et al*., 2012), giving rise to self-selection bias. Also, when the treatment group is not randomly assigned, households' decisions to participate in the market influenced by observed and unobserved characteristics such as educational attainment and managerial skills, respectively may also be correlated with the outcome variable of interest such as welfare leading to the problem of endogeneity. There is an issue of missing data because in reality one can only observe; $Y_i = T_{i1}Y_i + (1 - T_{i0})Y_{oi}$. Thus, only Y_i can be observed for programme participants and Y_0

for those who did not participate. Thus, only one outcome can be observed at a time and not both simultaneously. This makes it impossible to directly measure the treatment effect because each farm household either participated in the programme or not and cannot be under both. This unobservable in either case is known as the counterfactual outcome. The fact that the counterfactual cannot be observed makes it impossible to estimate the treatment effects at the individual level. Nevertheless, the average treatment effect for the entire population can be estimated as: $ATE = E(Y_i) - E(Y_0)$.

To accurately measure the impact of the USAID-ADVANCE participation on an outcome variable, the treatment should be randomly assigned so that all farming households, both participants (treatment group) and non-participants (control group) would be placed on the same pedestal regarding observable and unobservable characteristics. The most robust approach considered in impact evaluation is called randomization. Randomization addresses the problem of self-selection bias by balancing confounding variables (both observed and unobserved) between treatment and control groups, and ensures that the control group represents the true counterfactual for the treatment group (Dibba, 2015). Randomization is a two-step procedure. First, random sample of eligible households are chosen from the entire population. The selected sample is then divided into treatment and control groups (Duflo *et al*., 2008). Second, the treated group is exposed to the treatment while the control group is not. In this case, the outcome variable of interest is observed from both groups. For example, out of the random sample of 1000 smallholder rice farmers, if 600 are randomly selected to participate in the programme and the remaining 400 do not, the impact can be estimated by taking the mean difference in outcome (*Y*) between

programme participants and non-participant. Thus, $ATT = E(Y_i|T_i = 1, X)$, where T and X represents treatment and control group, respectively.

Duflo *et al*., (2008) noted that *ATT* is the true impact of programme participation because of the balance between treated and control groups resulting from randomization. Randomization also ensures that both internal[4] and external[5] validities are achieved. When participants are randomly selected from a population, then the results obtained could be extrapolated to the entire population, hence, achieving external validity of the experiments. Also, when treatment is randomly assigned to the suitable participants it ensures that the mean difference in outcome between programme participants and non-participants emanated from the treatment and not from any confounding factors. Thus, the requirement for internal validity of the experiment is achieved. When these two conditions are satisfied, then the control group can be used as counterfactual for the treated group. In this case, the treated and the control have the same expected outcome prior to treatment, and therefore, sample selection which is one of the significant challenges in impact evaluation is zero. However, this is likely to happen only under pure randomization. Pure randomization ensures that the observed difference in outcome between treated and control groups is equal to zero before being exposed to the treatment. In this case, estimating the effect of the treatment with Ordinary Least Square (OLS) gives consistent and unbiased results.

Consider that the variable of interest (say welfare) is a linear function consisting of a vector of households and farm-level characteristics. The simplest approach to assessing the impact

[4] Internal validity is achieved when the causal effects of market participation is observed through randomization.
[5] External validity is achieved when the selected population under study is a representative of the entire population.

of programme participation on an outcome variable is to include in an outcome equation the treatment variable (say, *T*) denoting one (1) if farm household participates in the programme and zero (0) if otherwise. An ordinary least square (OLS) estimation technique can then be applied to assess the impact without the need to control for any confounding factors. However, if partial randomization exists where households are selected conditioned on observed covariates, then estimating the effect of the treatment with OLS provides biased results. Under such circumstances, it is possible to identify consistent and unbiased estimates of the treatment if participation in the programme is independent of the potential outcomes based on observed characteristics (World Bank, 2010). According to Ravallion (2008), treatment effect under partial randomization can be estimated based on the criteria used to randomly select both the treated and the control group, which can be expressed as; $ATT = E(Y_i|T_i = 1, X)$; where *ATT* is called the average treatment effect on the treated and *X* represents the exogenous factors used to randomly select households into treatment and control groups. The *ATT* can be estimated with OLS conditioning on the exogenous factors with the assumption that there is no selection bias due to the random assignment of the participants into treatment and control groups.

In partial experimental studies, the two relevant econometric approaches found in literature to deal with selection bias and endogeneity in cross-sectional data are Propensity Score (PS) methods and Endogenous Switching Regression (ESR) that use instrumental variable approaches (IV). PS only accounts for observable heterogeneity while IV accounts for both observable and unobservable heterogeneity.

4.6.1 Propensity Score

Propensity score (PS), as defined by Rosenbaum and Rubin (1983), is the probability of treatment assignment conditional on observed covariates. The propensity score is a baseline score, which can be defined as the distribution of some measure which is similar between treated and control groups. Thus, when the selected population has the same propensity score, the distribution of the observed covariates would be the same between treated and control groups (Austin, 2011). The PS occurs in both experimental or randomized studies and observational studies. In experimental studies, the PS can be known and defined by the study design while it is not generally known in observational studies. However, PS can be estimated using the observational data. In practice, PS is mostly estimated using binary regression models such as logit or probit where treatment status is regressed on some observed covariates (Lee *et al*., 2010). The predicted probability of treatment generated from the fitted model is the propensity score (Austin, 2010). Aside logit and probit procedure of deriving the PS, other methods such as bagging or boosting (McCaffery *et al.*, 2004; Lee *et al.*, 2010), recursive partitioning or tree-based (Setoguchi *et al.*, 2008; Lee *et al.*, 2010), random forests (Lee *et al.*, 2010), and neural networks (Setoguchi *et al.* 2008) have been identified.

In observational studies, four main PS methods have been well relied on in literature to account for potential confounding covariates (Braitman and Rosenbaum, 2002; Cepeda *et al.*, 2003; Kassie *et al.*, 2011; Worsen *et al.*, 2017; Danso-Abbeam and Baigunhi, 2018). These PS based approaches include Propensity score matching, Stratification, and Regression Adjustment (RA) or Inverse Probability Weighting (IPW) (Rosenbaum and Rubin 1983; Rosenbaum, 1987; Austin and Mamdani, 2006). The following paragraphs

briefly describe the four-propensity score approaches usually found in observational studies.

Impact evaluation using PSM approach entails constructing matched samples of treated and control groups with similar values of propensity score (Rosenbaum and Rubin, 1983; 1985). Once a comparison group is instituted, the treatment effect can be measured by a direct comparison of the difference between the mean outcomes of the treated and the control groups. In this case, the variance and the statistical significance of the treatment effect can be estimated once the effect of the treatment has been formed in the propensity score sample (Austin, 2011). Schafer and Kang (2008) argued that, the treated and the control group within the matched sample should be regarded as independent. However, Imbens (2004) noted that, one should use the appropriate technique to calculate the variance of the paired experiment whenever matched estimator is used. Adding to the argument of Imbens (2004), Austin (2011) suggested that, there are no independent observations in the matched sample when using propensity score. Instead, treated and control groups within the same matched set have similar propensity score values, therefore, their observed characteristics emanate from the multivariate distribution. Hence, the lack of independence needs to be accounted for when dealing with propensity score matching procedure.

Stratification on propensity score consists of stratifying samples into mutually exclusive sub-samples conditioned on their values of propensity score. Samples are then ranked according to their propensity score and stratified based on predefined threshold of the estimated propensity score. Stratification is usually done by dividing the samples into five equal-size groups using quintiles of the estimated propensity scores. Cochran (1968) noted

that stratification based on quintiles eliminate about 90% of the bias due to confounding factors. Moreover, when estimating linear effect, stratification based on quintiles of the propensity eliminate approximately 90% of the bias resulting from measured confounders. Cochran (1968) and Hullsick, *et al.* (2002) indicated that increasing the number of strata used improves the bias reduction, however, as the marginal reduction in bias declines the number of strata increases. Within each stratum of the propensity score, the treated and the control groups share similar propensity score values.

Inverse Probability Weighting (IPW) uses weights to create a synthetic sample using the propensity score where the distribution of the measured covariates is independent of the treatment assignment (Morgan and Todd, 2008). In using the IPW, each sample is weighted by the inverse of the likelihood of receiving treatment. Thus, *1/PS* for the treated group and *1/(1-PS)* for the control group. The IPW is similar to survey sampling weighting technique that are used to weight survey samples so that they are representative of the population (Morgan and Todd, 2008). IPW was first suggested by Rosenbaum (1987) as a form of model-based direct standardization. Lunceford and Davidian (2004) made a lot of review regarding the estimators for treatment effects based on IPW. Nevertheless, weighting may be inaccurate or unstable when samples have low probability of receiving treatment (Robins *et al*., 2000). Further, the standard errors of the treatment effects may tend to be large if weighted propensity score is close to 1 or 0.

The last propensity score method is the Regression Adjustment (RA) based on propensity score. With this method, the variable of interest (outcome) is regressed on a treatment status, after which propensity score is estimated. The model choice is dependent on the nature of the outcome variable. If the outcome variable is continuous, a linear model is

most appropriate. For dichotomous outcomes, a binary model such as logit or probit may be selected. The coefficient of the estimated model is the effect of the treatment (Austin, 2011). When a linear model is fitted, the adjusted difference in means is the treatment effect whereas the adjusted odds ratio represents the treatment effects when logistic or probit regression is used. It must, therefore, be noted that RA is the only PS method that requires a specification of a regression model relating the outcome variable and the treatment status and some covariates. It also assumes that the model has been correctly specified, hence, can lead to biased and inconsistent estimates if the model is mis-specified.

To address the drawbacks of large standard errors and mis-specification with regard to IPW and RA, respectively, a doubly-robust estimation technique called inverse probability weighted regression-adjustment (IPWRA) has been identified. The doubly-robust estimation procedure corrects the drawbacks of both IPW and RA.

4.6.1.1 Propensity Score Matching

Participation in any farm intervention programme is hypothesized to increase productivity, household incomes and thus help to improve welfare. The study adopts the PSM technique to quantitatively estimate the impact of USAID-ADVANCE intervention programme on the welfare of the beneficiaries. In this case, we use sampled non-USAID-ADVANCE beneficiaries as a control group and the USAID-ADVANCE beneficiaries as the treatment group. The PSM technique matches the USAID-ADVANCE beneficiaries and non-USAID-ADVANCE beneficiaries based on their observed socioeconomic characteristics such as age, the level of education, marital status, farm sizes, etc. This is done to minimize or eliminate any biases that emanate from observed socioeconomic characteristics. The

PSM technique has been previously used to study observational data (Rosenbaum and Rubin, 1983).

The PSM framework outlined by Rubin (1974) and described by Angrist and Imbens (1991) was used. Following Heckman *et al.* (1976), the value of the outcome/impact variable; welfare is stipulated as Y_i when the household is subjected to treatment (USAID-ADVANCE participation, $P=1$) and Y_0 when the household does not participate (non-participants group, $P=0$). The observed welfare is specified as;

$Y = Y_1 P + (1-P)Y_0$ for a random sample of farm households. [12]

If ($P=1$), Y_1 is observed and if ($P=0$), Y_0 is observed. Y_1 and Y_0 represent potential welfare of a farm household that participates and that which does not participate respectively in the USAID-ADVANCE VC programme.

The average treatment effects on the treated *(ATT)*, which computes the mean difference in the outcome of the treatment group (participants) with or without the programme can be specified as;

$$ATT = E[(Y_i(1) - Y_i(0)/P_i = 1] = E[Y_i(1)/P_i = 1] - E[Y_i(0)/P_i = 1] \quad [13]$$

Where P is an indicator for participation in the USAID-ADVANCE intervention programme which takes the value of one (1) for the participants (treated group) and zero (0) for the non-participants (control group). $Y_i(1)$ and $Y_i(0)$ are the outcomes (in our case, welfare indicator which is proxied by consumption expenditure per capita, household income and farm income per acre) for the treated and control group, respectively.

The validity of the PSM depends on two main assumptions, namely, Conditional Independence Assumption (CIA) and the Common Support Assumption (CSA). The CIA states that given the set of covariates, the probability of programme participation condition and the outcome variable of interest in the absence of treatment are statistically independent (Takahashi and Barrett, 2013). The CSA states that the ATT is defined only within the region of common support (Danso-Abbeam and Baiyeghuni, 2018). The fundamental requirement of the CSA is that there should be a substantial overlap in observable characteristics between participants and non-participants such that the two groups being compared can be in both treated and non-treated group (Takahashi and Barret, 2013). When the conditions of CIA and CSA are met, then the *ATT* can be estimated using equation [13]. However, according to Shiferaw *et al*. (2014), PSM does not have the ability to correct for unobserved heterogeneity, it only deals with observed covariates to the extent that they are accurately estimated.

PSM estimation technique is a two-step procedure. First, the probability model (logit or probit) of participation in the USAID-ADVANCE is estimated to calculate the propensity score for each household. In the second stage, each participant is matched with non-participants with similar propensity score value in order to estimate *ATT* (Abadie and Imbens, 2006). After matching the participants and non-participants on the propensity score, the average treatment effect on the treated (*ATT*) is calculated as the weighted difference between the treated and matched control group. The *ATT* measures the impact of the USAID-ADVANCE intervention programme on the welfare of the farm households participating in the programme. This can be calculated as:

$$ATT = E(Y^P - Y^{NP} \mid P = 1) = \frac{1}{N_P}\left[\sum_{i \in P} Y_i^P - \sum_{j \in NP} \omega(i, j) Y_i^{NP}\right] \quad [14]$$

where Y_i^P and Y_i^{NP} are the outcome (welfare) of the participants and non-participants, respectively. N^P is the number of participants in the sample, and $\omega(i, j)$ is the weight factor used in the matching. We then estimate the *ATT* using propensity score matching for all the three-dependent variables of interest used to define farm household welfare. The PSM technique elaborated has been used extensively in literature to estimate the treatment effects of such intervention programmes on outcome variable of interest (Shiferaw *et al.*, 2014; Abate *et al.*, 2016; Rutherford *et al.*, 2016).

In estimating the true impact of the intervention programme on the welfare of the participants with PSM, many matching procedures have been suggested in many pieces of literature (Imbens, 2004; Rosenbaum, 2002). This is because PSM is very sensitive to the exact specification and algorithm (Imbens, 2004). Therefore, as a robustness of the results, the study employed three matching techniques of PSM. These techniques are Nearest Neighbour Matching (NNM), Kernel-based Matching (KBM) and Radius Matching (RM), which are frequently used, in analyzing impact of an intervention programme on farm household welfare (see Gebrehiwot, 2015; Ali *et al.*, 2016). Nearest neighbor matching matches individual sample in the treatment group with that of the control group as close as possible (Rubin and Thomas, 2000). This can be applied with or without replacements in the control group (Rosenbaum, 2002). Matching with replacements involves a given sample in the control being included in more than one matching process. In this case, a selected individual in the control group is still available to be used in the subsequent matches against the treatment group (Austin, 2011). On the contrary, matching without

replacement does not allow a selected individual in the control group to be used in the subsequent matching process.

The kernel-based procedure matches all participants with non-participants by assigning a weight such that they are inversely proportional to the distance between the propensity scores of the participants and the non-participants. In kernel matching, more information is used to construct the counterfactual outcome of the control group. This reduces the variance but increases the bias when matching is not properly done (Caliendo and Kopeinig, 2008).

In radius matching, every individual sample in the treated group is matched to only the individual sample in the control group with propensity scores within a pre-defined region of the propensity scores of the treated sample. In this case, the dimension of the region (radius) is set for the matching process. Small dimension (radius) enhances the quality of the matching process but has the potential to eliminate some samples from the control group (Becker and Ichino, 2002).

The stratification matching process, which has not been employed in this study occurs where the propensity scores of the samples are stratified such that in each stratum, both the treated and the control samples have the same propensity scores. A critical limitation of this matching technique is that it discards a stratum where both treated and control observations are not present.

After estimating the ATT with the matching algorithms, a diagnostic test was performed to check the quality of matching process. This is to ensure that the observed characteristics of both the treated and control samples have been balanced out. This is done by comparing

the observed characteristics before and after matching to check if any differences in the observed characteristics exist after conditioning on propensity score. According to Caliendo and Kopienig (2008), a Pseudo-R^2 can be used for the balancing test. In this case, the *Pseudo-R^2* explains how well an observed characteristic *"X"* explains the probability of participation, and the values of the *Pseudo-R^2* before and after matching is compared. A relatively small *Pseudo-R^2* and the rejection of the joint significance of the covariates should be the situation after matching (Ali and Abdulai, 2010). In fact, there should not be any systematic difference in covariates between the treated and the control groups after matching. When these systematic differences have been eliminated, the matching process is considered as efficient and the comparison group considered as a reasonable counterfactual (Heckman and Vytlacil, 2005; Ali and Abdulai, 2010). In-addition, some institutional or policy variables such as workshop attendance, visit to demonstration plots might be endogenous to the GAPs and marketing strategies but must indicate that these did not come with the intervention package but some were used as channels to implement some of the practices/packages.

4.6.1.2 Sensitivity test of hidden bias

The condition independence underlying the PSM requires that all variables that influence both the decision to participate in the ADVANCE programme and the outcome variable of interest (welfare) are captured. If there are other unobserved characteristics of the respondents that affect both the programme participation and welfare, then matching estimators may not be robust due to the possibility of hidden bias (Rosenbaum 2002). Therefore, assessing the extent to which the estimates from the PSM is sensitive to hidden bias becomes critical. The study employed Rosenbaum bounding approach (Rosenbaum

2002) diagnostic test to examine the extent to which hidden biases that may come from unobserved variables affect the estimates from the PSM.

Following Rosenbaum (2002), the odds ratio for the bounding method can be expressed as;

$$\frac{1}{\tau} \leq \frac{P_i(1-P_i)}{P_j(1-P_j)} \leq \tau \qquad [15]$$

Where $\tau = 1$ suggests that the odds of treatment is the same and there is an absence of hidden biases, while every increase in the value of τ would also indicate non-existence of hidden bias. DiPrete and Gangi (2004) noted that if τ is smaller (less than 2), then the likelihood of having some unobserved covariates affecting the outcome variable is very high and the estimated results are therefore associated with unobserved characteristics of the respondents. Thus, τ is a measure of the extent of departure of an estimate that is free from hidden bias (Rosenbaum 2002).

4.7 Definition of Variables

In this section, the study describes two main categories of variables namely, dependent and explanatory variables based on the review of existing literature on the outcome variables of interest when evaluating impact of an intervention programme as well as factors explaining adoption of technologies.

Dependent variables: the dependent variables can also be categorized into two main groups. The first group consists of selection of dependent variables which are dichotomous in nature. The selected dependent variables are adoption of GAPs (i.e., certified seeds, row planting and fertilizer application) and marketing strategies (labelling of products, grading

and collective marketing). These were measured as dummies, 1 for adopters and 0 for otherwise. Thus, farmers were asked whether they planted in rows, used certified seeds or applied fertilizer on their farms in the 2016 farming season. Farmers were also asked to indicate whether they sorted their produce after harvest (grading), labelled their produce after package and engaged in collective marketing. Farmers who responded "yes" to these practices are referred to as adopters and coded 1. However, those who responded no are called non-adopters and were coded 0.

Following many empirical studies (e.g., Danso-Abbeam *et al*., 2018; Danso-Abbeam and Baiyeghunil, 2018; Awotide *et al*., 2016; Mwansakilwa *et al*., 2017), the second group of the dependent variable comprises of five main variables of interest. These include productivity, farm income per acre, household income, annual consumption expenditure and consumption expenditure per capita. Farm productivity (yield) is defined as the total output of crops in kilograms per hectare while farm income per acre is measured as the total sales of crops for every acre of land under cultivation. The total household income was captured as the summation of the revenues from all crops cultivated, revenues from livestock, and incomes from off-farm (income earned from working in another farm) and non-farm income generating activities such as salaries from formal work and self-employed business. All these incomes from the members of the household – household head, spouses and other economically active members summed up as household income.

The annual consumption expenditure was defined as the total household expenditure covering 12 months of the previous year. This was calculated using the cost of food (i.e., consumption of home-produced food + purchased food items + gift food items from friends and relatives) and expenditure on non-food items (e.g., medication, education, funerals,

among others) for every month and combined to a year. The consumption per capita variable was then captured as annual consumption expenditure adjusted for adult equivalent. In adjusting for the adult equivalent, the study used "the square root scale" introduced by the Organization of Economic Co-operation and Development (OECD) (2011). With the square root approach, the annual consumption expenditure is divided by the square root of the household size. Consistent with some other studies (Danso-Abbeam *et al*., 2018; Awotide *et al*., 2016), the study hypothesizes that participation in ADVANCE intervention programme leads to positive gains in the various indicators of welfare.

Independent Variables: the study followed many other studies (Danso-Abbeam and Baiyeghuni, 2017; Wosen *et al*., 2017; Khonje *et al*., 2015; Gillespie *et al*. 2014; Teklewood *et al*., 2013) to draw its model specification. These and many other studies have focused on four main categories of characteristics namely; household demographic characteristics, household assets, institutional or policy variables, and location variables. The paragraphs that follow outline the description of the explanatory variables and their *apriori* expectations on the adoption of the GAPs practices and marketing strategies as well as the probability of participating in USAID-ADVANCE intervention programme.

Farm household demographic characteristics such as sex, age, educational attainment, number of years in crop farming proxied as farm experience, and other socioeconomic variables have been identified to have significant influence on adoption of farm technologies as well as the probability of participation in agrarian intervention programmes such as ADVANCE. Many studies have concluded that males are likely to adopt technology than female (Abdulai, 2016). This could partly be attributed to the fact that men have greater access to productive resources than women, especially in African

communities (Denkyirah *et al*., 2016; Ndiritu *et al.,* 2014). Following this notion, the study expects male to have a higher probability of adopting the technologies under study and have a greater propensity to participate in intervention than their female counterparts. The effects of age on farm technology adoption and participation of intervention programmes have been mixed. One strand of literature (Asfaw *et al*., 2012; Nmadu *et al*., 2015) had age as a positive and significant effect on adoption of farm technology such that older farmers are more experienced in crop production and are more familiar with the production environment much better than the young. The other strand posited (e.g., Denkyirah *et al.*, 2016; Danso-Abbeam and Baiyeghuni, 2018; Afolami *et al*., 2015) that farmers become more risk-averse as they grow old and hence, are less likely to adopt as compared with the young farmers who are more likely to take the risk associated with agricultural technology. Thus, the effects of age on GAPs, marketing strategies and participation have been hypothesized to be indeterminate. Similarly, the number of years farmers have worked in farming activities has been identified to have significant and positive influence on farm technology adoption. This is evident in many empirical studies such as Islam *et al*. (2012) and Ojo and Ogunyemi (2014). The study, therefore, hypothesized positive effects of experience on farm technology and participation of ADVANCE programme. Household size which in most cases reflect the supply of family labour has been hypothesized to affect participation and adoption negatively or positively. This is because, on one hand, large household size provides free labour and hence, could enhance adoption (Sodjinou *et al*., 2015). On the other hand, large household size has the possibility of competing for same cash resources that would have been used to purchase farm resources, hence may negatively affect adoption (Martey *et al*., 2015). The number of years in formal education

(educational attainment) plays a critical role in enhancing production through adoption of agricultural technologies and participation in intervention programmes. Some studies (Ahmed, 2015; Gebresilassie and Bekele, 2015) have argued that educational attainment increases the probability of adoption of farm technologies, which in turn, improves farm productivity. The study, therefore predicts a positive effect of education on adoption of GAPs and marketing strategies as well as the probability of participation in ADVANCE programme.

Household assets, including ownership of farm, off-farm business, livestock, ownership of donkeys, bicycles, tricycles and radio/TV, have been documented to have a great potential to positively and significantly increase adoption of farm technologies and enhance participation of agricultural intervention programmes. For instance, Afolami *et al*. (2015) posited that ownership of donkeys, radio, television and mobile phones increases the level of adoption of farm technology. Thus, the study suggests that household assets will affect adoption and participation positively.

Previous and recent empirical studies (Ransom *et al.*, 2003; Diiro, 2013; Mmbando and Baiyeghuni, 2016; Danso-Abbeam and Baiyeghuni, 2018) have documented the positive effects of institutional and policy variables such as workshop attendance, demonstration farm visits and agricultural extension services on agrarian technology adoption as well as participation in farm intervention programmes. The study included institutional variables such as workshop attendance, demonstration farm visits, membership of social group such as Farmer based-organizations, access to market information, access to storage facilities and agricultural extension services. These variables were dummied as 1 if farmers had accessed to the services and 0 otherwise.

Table 4.2: Description of variables, measurements and apriori expectations

Variable	*Description*	*Measurement*	*apriori expectation*
Independent Variables			
Sex		Dummy, male =1	-/+
Age	Age of respondent	Years	-/+
Education	Number of years in School	Years	+
Experience in farming	Number of years in crop farming	Years	+
Household size	Number of individuals eating from the same pot	Count	-/+
Non-farm business	Engagement in non-farm economic activities	Dummy: Non-farm = 1, 0 otherwise	+
Livestock	Household owns Livestock	Dummy = 1, if yes, 0=otherwise	+
Donkeys	Household owns donkeys	Dummy: Yes = 1, 0 otherwise	+
Radio/TV	Household owns TV/Radio	Dummy: Yes = 1, 0 otherwise	+
Workshop attendance	Household has attended agricultural workshop	Dummy: Yes = 1, 0 otherwise	+
Demonstration visits	Household has visited demonstration field	Dummy: Yes = 1, 0 otherwise	+
Agric. extension Service	Household has received agricultural extension services	Dummy: Yes = 1, 0 otherwise	+
Farmer-based organization	Household is a member of any FBO	Dummy: Yes = 1, 0 otherwise	+
Access to market information	Household has access to input and output prices	Dummy: Yes = 1, 0 otherwise	+
Access to storage facilities	Household has access to storage facility	Dummy: Yes = 1, 0 otherwise	+
Distance to market	Distance to the nearest output and input market	kilometers	+

CHAPTER FIVE

5.0 RESULTS AND DISCUSSIONS-DESCRIPTIVES

5.1 Descriptive Analysis of the Survey

This section discusses the descriptive statistics of the sampled respondents. In all, 673 farm households (394 USAID-ADVANCE beneficiaries and 279 non-beneficiaries) were interviewed across the (former) three northern regions. The descriptive statistics comprise the demographic characteristics of both the USAID-ADVANCE beneficiaries and non-beneficiaries. This is to understand the demographic features of the respondents and also to examine whether significant differences exist between USAID-ADVANCE beneficiaries and non-beneficiaries regarding their observed characteristics. The study also makes a comparison between USAID-ADVANCE beneficiaries and non-beneficiaries regarding their productive activities. Finally, the study focus on the USAID-ADVANCE beneficiaries (since they are the group of interest) and perform some comparative analysis across the (former) northern regions according to crop type.

5.2 Demographic Characteristics of the Sampled Farm Households

The demographic characteristics of the sampled respondents are presented in Table 5.1. About 60% (40%) of the respondents in the intervention programme are male (female) while about 75% (25%) of the non-participants are male (female). This suggests that the intervention programme consciously incorporated gender equity into the programme. This is because in a normal Ghanaian society, particularly, in the northern part of the country, women usually pull out and allow the men to participate in such programmes. About 40% of women participation in an intervention programme is a good indication of women

empowerment in the northern part of the country. About 81% of the participants are married while 79% of the non-participants are married. The average household size of the participants and non-participants are about 10 and 12 persons respectively. USAID-ADVANCE members, on the average, have spent about 22 years in crop production while non-USAID-ADVANCE members have about 24 years of experience in crop farming.

Table 5.1:Distribution of household characteristics by participation in the ADVANCE programme

Description of variables	*USAID/ADVANCE participants*	*Non-USAID/ ADVANCE participants*	*Mean difference*
Household Characteristics			
Proportion of male in the sample	0.599	0.746	-0.148[a]
Proportion of married farmers in the sample	0.81	0.79	0.02
Household Size (# of persons)	9.824	11.777	-1.952
Number of years in crop Farming	21.571	23.502	-1.93[b]
Number of years in Formal Education	5.58	5.769	-0.188
Number of household members in School (persons)	4.096	3.659	0.437
Household Assets			
Farm Size (acres)	8.237	7.691	0.545
Off-farm income activities (dummy, yes = 1)	0.677	0.358	0.32[a]
Ownership of Donkey (dummy, yes = 1)	0.653	0.616	0.04
Ownership of Motor bike (dummy, yes = 1)	0.953	0.916	0.04
Ownership of Tricycle (dummy, yes = 1)	0.784	0.549	0.235[a]
Ownership of TV/or Radio (dummy, yes = 1)	0.806	0.802	0.004
Institutional/Policy Variables			
Workshop Attendance (dummy, yes = 1)	0.477	0.158	0.319[a]
Visit to demonstration Farms (count)	2.85	1.95	0.90[a]
Other Agricultural training received (dummy, yes =1)	0.449	0.157	0.292[a]
Membership of Social group (dummy, yes =1)	0.406	0.262	0.144[a]
Access to market information (dummy, yes = 1)	0.763	0.576	0.187[b]
Access to storage facilities (dummy, yes = 1)	0.594	0.487	0.106
Received Gov't extension services (dummy, yes = 1)	0.297	0.369	-0.07[c]
Location Variables			
Distance to the nearest Output Market (minutes)	35.696	38.612	2.916
Upper East Region (dummy, yes = 1)	0.292	0.311	-0.019
Upper West Region (dummy, yes = 1)	0.322	0.331	-0.009

a, b, and c denote levels of significance at 1%, 5% and 10% respectively
Source: Field Survey, 2016.

Also, the number of years spent in formal education was about 6 for both participants and cultivate an average farm plot of about 8 acres (thus rice, maize and soybean). Moreover, about 68% of the USAID-ADVANCE members are engaged in off-farm income compared with 35% of the non-USAID-ADVANCE members. About 78% of the USAID-ADVANCE members owns tricycle (locally known as “motorking”), compared with 55% of the non- USAID-ADVANCE members.

Workshops are usually organized by programme facilitators to train farmers on farm financial management, such as crop budgeting, business planning, and basic cost-benefit analysis to complement the technical knowledge on agricultural production farmers received from demonstration plots. The results indicate that a higher proportion of USAID-ADVANCE members have visited farm workshops and have had training from demonstration plots than non- USAID-ADVANCE members. Also, more USAID-ADVANCE members have received other agricultural trainings, access to market information, and access to storage facilities than non-USAID-ADVANCE members. However, only a few (about 30%) of the USAID-ADVANCE members have received extension services from the government.

5.3 Adoption of GAPs and Marketing Strategies by USAID/ADVANCE

Beneficiaries and non-beneficiaries

The selected GAPs and marketing strategies supposed to be adopted as a package are certified seeds, row planting, fertilizer application, labelling of products, grading of

produce and collective marketing. The intensity of adoption[6] of these GAPs and marketing strategies by USAID-ADVANCE members are compared with sampled non-USAID-ADVANCE farmers from non- USAID-ADVANCE catchment districts. This comparison is necessary so that the non- USAID-ADVANCE members can serve as control group against which performance of USAID-ADVANCE members can be assessed. The results are presented in Table 5.2. Table 5.2 indicates that 54%, 75.6%, and 92.8%, of the farmers in USAID-ADVANCE programme adopted certified seeds, row planting and fertilizer on their plots respectively as against 28.7%, 65% and 86.3% of the non-USAID-ADVANCE participants adopting the same set of technologies. The high adoption observed with ADVANCE farmers could be ascribed to easy access of these inputs to them than the non-ADVANCE farmers and the tendency of them being more resource endowed than their counterparts. The fact that ADVANCE farmers received trainings on the significance of these practices with respect to productivity could also be a contributory factor in influencing the high adoption rates. Further, 48%, 12.4% and 11.1% of the USAID-ADVANCE members had adopted labelling, grading and collective marketing as compared with 63.8%, 11.8% and 9.4% respectively for non-USAID-ADVANCE members.

[6] Intensity of adoption here refers to the proportion of farmers adopting a particular component of GAPs and marketing strategy.

Table 5.2:Distribution of GAPs and Marketing Strategies: ADVANCE and non-ADVANCE beneficiaries

GAPs/Marketing Strategies	*ADVANCE participants*	*Non-ADVANCE participants*	*Difference*
Adoption (dummy, 1 = yes)			
Use of certified seeds	0.537	0.287	0.250[a]
Row planting	0.756	0.65	0.107[a]
Fertilizer application	0.928[7]	0.863	0.065[a]
Labelling	0.480	0.638	-0.158[a]
Grading (weighing and sorting)	0.130	0.118	0.012
Collective marketing	0.116	0.094	0.022

[a] *denote significant at 1% level*
Source: Field survey, 2016

5.4 Farm performance indicators by crop and participation in USAID/ADVANCE programme

Table 5.3 reports a comparative analysis of performance indicators by crop between USAID-ADVANCE participants and non-participants. These performance indicators are used to assess the productive use of land for each crop and its effects on farm income. The results indicate that USAID-ADVANCE participants had larger farm areas allocated to maize and soybean production than non- USAID-ADVANCE members, whereas non-USAID-ADVANCE members allocate more farm lands to rice production than USAID-ADVANCE members. Similarly, USAID-ADVANCE farmers outperformed the non-USAID-ADVANCE farmers in maize production as indicated by the maize farm output of 9025kg and 950kg/acre for ADVANCE members, as against 7480kg and 880kg/acre for

[7] This figure refers to the proportion of farmers applying fertilizer on their rice and maize field only. It does not include fertilizer application on soybean fields. Generally, farmers do not generally apply fertilizer on their soybean field. The study found only a fraction of them as indicated in Table 5. Hence, its exclusion.

non-ADVANCE members. Regarding rice, although non-participants allocated larger farm plots to the production of rice, USAID-ADVANCE members had better farm output and yield than the non- USAID-ADVANCE members.

Table 5.3: Distribution of performance indicators by crop and beneficiaries and non-beneficiaries of USAID/ADVANCE

	Participants			***Non-Participants***		
	Maize	Rice	***Soybean***	***Maize***	***Rice***	***Soybean***
Farm size (acreage)	9.5	8	6.5	8.5	8.5	6
Farm Output (kg)	9,025	8,400	3,900	7,480	7,225	4,800
Output/acre (kg/acre)	950	1050	600	880	850	800
Farm Income (GH¢)	5,866	6,349	4,786	4,462	5,461	5,890
Farm Income/acre (GH¢)	618	794	736	572	642	982

Note: The price range for maize and rice was GH¢60 – 70/100kg and that of soybean was GH¢135/100kg. The study, therefore, used the average price of GH¢65 for both rice and maize, and GH¢135 for soybean.

However, non-members performed better in soybean production than members of USAID-ADVANCE as indicated by the yield of 800kg/acre versus 600kg/acre. Considering the fact that both parties do not apply inorganic fertilizer to their crops, the high productivity observed by non-ADVANCE farmers could be attributed to natural fertility of the land/soil used by them for the farming activities. The results further showed that farm productivity measured by output per acre had a significant effect on farm income. For instance, although participants on the average operated relatively small farm lands regarding rice production, output per acre was larger, and that translated into greater farm income and farm income per acre.

5.5 Plot size and crop yield of USAID/ADVANCE members by crop and region

Since USAID/ADVANCE members are the focus of this study, we now concentrate only on participants to understand how productive they are by crop-specifics across the three regions. Table 5.4 shows the distribution of plot size by crop, while Figure 5.1 indicates the productive performance of the members across the three regions.

Table 5.4:Distribution of plot size of ADVANCE participants by crop and region

Plot Range (acres)	*Northern*	*Upper East*	*Upper West*	*Total*
		Maize		
1 – 5	52.16	68.23	73.5	54. 60
5.5 -10	28. 80	23.15	20.05	27.5
10.5 - 15	13.14	7.12	5.65	14.75
> 15	5.9	1.5	0.8	3.15
Total	100	100	100	100
Mean	11	9.5	7.5	
		Rice		
1 – 5	88.5	90.65	87. 45	89.25
5.1 -10	7.5	8.5	10.52	8.75
10.5 - 15	4	0.85	1.5	1.85
> 15	0	0	0.53	0.15
Total	100	100	100	100
Mean	9	8.5	6.5	
		Soybean		
1 – 5	65.87	92.88	95.05	78.65
5.1 -10	24.6	5.55	4.95	16.56
10.5 - 15	7.25	1.57	0	3.32
> 15	2.28	0	0	1.47
Total	100	100	100	100
Mean	7.5	6.5	5	

Table 5.4 shows that while about 68% and 74% of farmers in Upper East and Upper West regions operate on small maize farmland ranging between 1 – 5 acres, about 52% of farmers from the Northern region farm on the same range of maize plot size. Only a fraction of farmers across all the three regions had maize farmland greater than 15 acres. Similarly, the majority (greater than 89%) of the farmers across the regions farm less than 5 acres of rice farm. Likewise, in the case of soybean production, nearly all the farmers in Upper East and Upper West operate farm plots in the range 1 – 5 acres. However, about 34% of farmers in the northern region farmed more than 5 acres of soybean.

Further, Figure 5.1 compares crop-specific yields of farmers across the three northern regions. It is observed that while the average yield of maize, rice, and soybean for the Upper West region were 950kg/acre, 1050kg/acre and 550kg/acre, respectively, for the Northern region 800kg/acre, 850kg/acre and 450kg/acre for maize, rice, and soybean were recorded respectively[8]. Interestingly, the Upper East region outperformed the other two regions in all the crops, with reported yield of 1100kg/acre, 1250kg/acre and 780kg/acre for maize, rice and soybean, respectively. These are against achievable yields of 5,500kg, 6000kg and 3500kg for maize, rice and soybean respectively. The low yields recorded compared with achievable are mainly due to partial adoption and non-adoption of the practices by beneficiaries and non-beneficiaries of the intervention programme.

[8] 1 acre = 0.4047 hectares

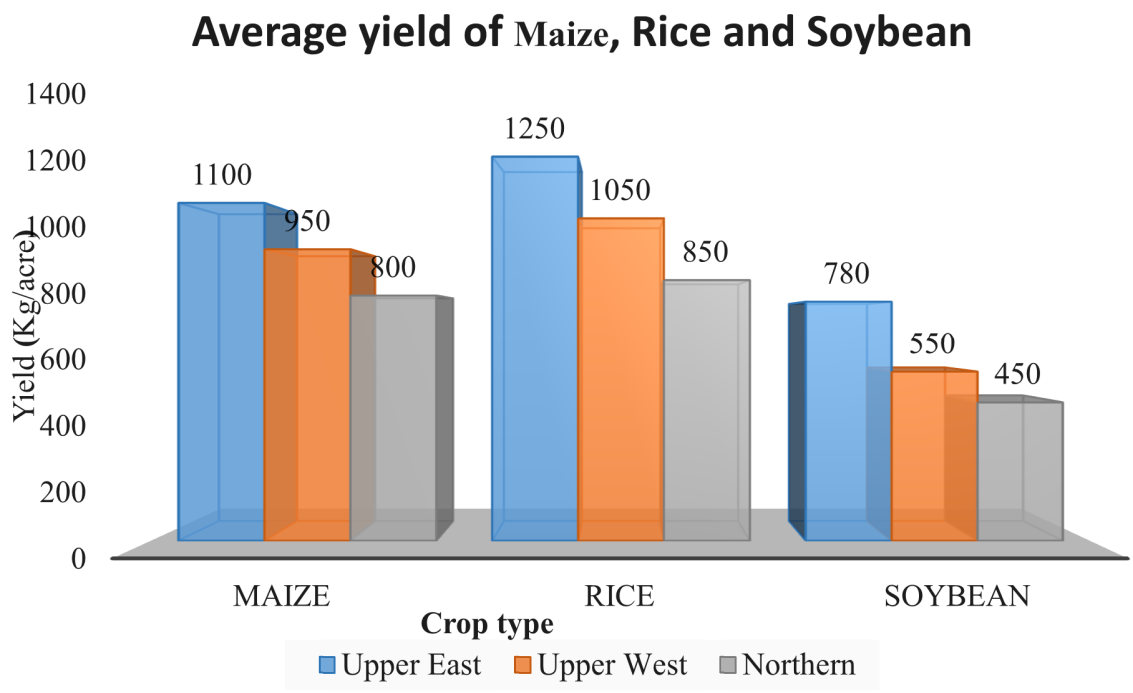

Figure 5.1: Average yield of maize, rice and soybean by crop and region for ADVANCE beneficiaries
Source: Field survey, 2016

5.6 Adoption Distribution of GAPs and Marketing Strategies by Crop and Region – USAID/ADVANCE members

Table 5.5 presents the adoption of GAPs and marketing strategies adopted by USAID/ADVANCE sampled farmers across the three northern regions. The results indicate that farmers across the three regions have high fertilizer adoption intensity for both maize and rice production.

Table 5.5: Adoption distribution of ADVANCE members by GAPs/Marketing Strategies and regions

GAPs/Marketing Strategies	*Northern*	*Upper East*	*Upper West*	*Mean*
		Maize		
Certified seeds	0.72	0.78	0.70	0.73
Row Planting	0.82	0.82	0.70	0.78
Fertilizer application	0.92	0.95	0.91	0.93
Labelling	0.56	0.47	0.35	0.46
Grading (weighing and sorting)	0.23	0.15	0.08	0.15
Collective Marketing	0.16	0.16	0	0.11
		Rice		
Certified seeds	0.68	0.74	0.68	0.70
Row Planting	0.71	0.76	0.72	0.73
Fertilizer application	0.90	0.96	0.89	0.92
Labelling	0.49	0.46	0.30	0.42
Grading (weighing and sorting)	0.16	0.12	0.07	0.12
Collective Marketing	0.13	0.18	0.05	0.12
		Soybean		
Certified seeds	0.21	0.19	0.15	0.18
Row Planting	0.76	0.84	0.68	0.76
Fertilizer application	0.02	0.05	0.03	0.033
Labelling	0.55	0.58	0.52	0.55
Grading (weighing and sorting)	0.14	0.13	0.1	0.12
Collective Marketing	0.18	0.12	0.05	0.12

Source: Field Survey, 2016.

Thus, at least, 89% of the farmers in all the regions applied fertilizer in their maize and rice farms. However, only a fraction (3.3%) of farmers across the three regions applied fertilizer on their soybean fields. Adoption of certified seeds of maize and rice in all the three regions was quite high. Adoption of certified seeds of soybean was very low in all the regions as the maximum intensity of adoption was 21% achieved by the farmers in the Northern

region. Moreover, adoption of row planting is relatively high among farmers in all the regions. The high adoption of certified seeds and fertilizer across the regions can largely be as a result of easy access to these inputs and the facilitation role of ADVANCE. The low adoption of certified soybean seeds and fertilizer application was as a result of their unavailability and high prices.

Regarding marketing strategies, product labelling recorded the highest use in all the crops across all the three regions, though adoption is still below expectation. Similarly, farmers across all the regions seem not to be interested in grading and collective marketing irrespective of the product. The lukewarm attitude of farmers towards adoption of marketing practices may be due to the situation where farmers still produce for subsistence rather than for sale.

CHAPTER SIX

6.0 RESULTS AND DISCUSSIONS-EMPIRICS

6.1 Determinants of Participation in the USAID/ADVANCE Programme

The conditional probability of participating in the ADVANCE programme was estimated from the Probit model to predict the propensity score of both participants and non-participants. The results of the estimated Probit model of the determinants of the programme participation is presented in Table 6.1. The Probit model is statistically significant at 1% as indicated by likelihood ratio value (*LR chi-square (22) = 302.92; p = 0.000*). In order to provide a meaningful interpretation of the magnitude of the coefficient of parameters, the study estimated the marginal effect which was used to interpret the results. The sign of the marginal effect values indicates the direction of the influence of the covariates on the dependent variable while the magnitude shows the size of the effects.

The results from Table 6.1 show that sex is a significant determinant of the probability of participating in the ADVANCE programme. Thus, being a male give one about 22% likelihood of participating in the programme. This is not surprising as men as household heads have full control over family resources, particularly in developing countries like Ghana. Possession of farm productive assets have been identified by many similar studies (Wossen *et al*., 2017; Ma and Abdulai, 2016) to enhance farmers' participation in an agricultural intervention programme.

Table 6.1: Determinants of participation in USAID-ADVANCE Programme

Description of variables	*Coeff.*	*Std. Error*	*Marginal Effects*
Household Characteristics			
Sex	0.5670	0.1373	0.2171[a]
Proportion of married farmers in the sample	0.0196	0.1726	0.0196
Household Size	0.0069	0.0126	0.0069
Number of years in Crop Farming	-0.0050	0.0051	-0.0050
Number of years in Formal Education	-0.0108	0.0160	-0.0041
Number of Household members in School	0.0215	0.0263	0.0215
Household Assets			
Farm Size	0.0016	0.0061	0.0016
Off-farm income activities	1.1139	0.1736	0.4021[a]
Ownership of Donkey	0.4151	0.2392	0.1438[c]
Ownership of Motor bike	0.4468	0.1520	0.1702[a]
Ownership of Tricycle	0.5460	0.2279	0.1871[b]
Ownership of TV/or Radio	0.4014	0.1810	0.1553[c]
Institutional/Policy Variables			
Workshop Attendance	0.3337	0.1401	0.1231[b]
Visit to demonstration Farms	0.3185	0.1346	0.1180[b]
Other Agricultural training received	0.5236	0.1462	0.1885[a]
Membership of Social group	0.5015	0.1489	0.1817[a]
Access to market information	0.2143	0.1471	0.0798
Access to storage facilities	0.1317	0.1299	0.0496
Received Gov't extension services	0.0778	0.1580	0.0291
Location Variables			
Distance to the nearest Output Market	0.0005	0.0016	0.0002
Upper East Region	0.1722	0.1887	0.0646
Upper West Region	1.4416	0.2195	0.5276[a]
Constant			
Pseudo R^2	*0.3322*		
LR Chi2 (22)	*302.98*		
Prob>Chi²	*0.000*		

[a, b,] and [c] denote significance levels at 1%, 5%, and 10%, respectively

Source: Field Survey, 2016

This assertion is also evidenced in the present study as the probability of farmers' participation in the ADVANCE programme is positively and significantly influenced by engagement in off-farm economic activities, ownership of donkey, motorbikes, and

tricycle. Farmers own these assets to make farming operations easier and increase productivity. These farmers, likewise, would consider such an intervention programme as a huge opportunity to learn new farm techniques and improve their managerial skills. Engagement in off-farm income, ownership of donkeys, motorbikes, and tricycles enhance the likelihood of participation by 40%, 14%, 17%, and 18%, at significance levels of 1%, 10%, 1%, and 5% respectively.

Similarly, the likelihood of participation in ADVANCE programme is influenced by supply-side policy variables such as workshop attendance, visit to demonstration farms, other agricultural training programmes, and membership of the social group. Attending farm workshops, visits to demonstration farms, and other agricultural trainings received help increase farmers' knowledge and understanding of productive technologies and agricultural marketing strategies. These serve as a source of motivation, and hence, enhance participation in intervention programmes such as ADVANCE[9]. The study findings are consistent with that of previous studies (Belemare, 2012; Rutherford, 2016) that have reported a positive and significant effect of these supply-side policy instruments on agricultural intervention programmes. Moreover, participants located in the Upper West region have a greater propensity to participate in the programme compared with their counterparts in the Northern region.

[9] Farmers were specifically asked whether they have attended any workshop before joining ADVANCE. That is Non-ADVANCE workshop.

6.2 Maximum Likelihood Estimation Results of the Determinants of GAP Adoption

The results from the MVP analysis in equations [5] and [6] are presented in Table 6.2 and 6.3. Table 6.2 presents the correlation (equation [5]) amongst the various GAPs and marketing strategies adopted by the smallholder farmers in the study area, whereas Table 6.3 reports on the determinants of the adoption decisions (equation [6]).

6.2.1 Nature of the Relationship Between the Technologies

The correlation matrix among the various components of the GAPs and marketing strategies generated from the MVP using equation [5] is presented in Table 6.2. From the matrix, each of the components of the VC package is paired generating a pair-wise correlation. The likelihood ratio (LR) test measures the overall correlation among the components of the package. It tests the null hypothesis that there is no correlation among the components of the package. Since the value of the LR is significant ([χ^2 (15) = 190.971; p = 0.000], the null hypothesis that there is no correlation among the various components is rejected. Thus, there is an overall correlation among the various components of the VC package. Hence, the use of the MVP is appropriate to analyze the mutual interdependence among the multiple GAPs and marketing strategies. This result is supported by most of the pair-wise correlations in the table. A positive correlation coefficient (e.g., a correlation of 0.466 between row planting and certified seeds) indicates that the two components are complements. Thus, farmers who plant in row combine it with the use of certified seeds. These two agronomic practices are activities that are jointly undertake by farmers as they complement each other. The reverse applies to a negative correlation coefficient. The entire set of correlation coefficients is positive, indicating that there is a positive correlation (complementarity) correlation between the different GAPs and marketing strategies. This

suggests that the adoption of a given farm technology or marketing strategy is based on whether another farm or marketing practice in the subset has been adopted. For instance, a farmer's decision to use fertilizer depends on whether or not a certified seed or row planting was adopted. The highest correlation is between labelling and collective marketing (51%), followed by row planting and grading (48%) and then certified seeds and row planting (47%). The smallest correlation is between fertilizer application and labelling (1%). Labelling and collective marketing are two related activities that are often undertaken together by farmers. Thus, collective marketing is dependent on labelling of the produce. Labelling actually enhances collective marketing by farmers as they can easily identify their goods/bags should there be challenges with the produce.

Table 6.2: Correlation Matrix of the Technologies from the Multivariate Probit Model

	Row Planting	***Fertilizer Application***	***Grading***	***Labelling***	***Collective Marketing***
Certified seed	0.466 (0.063)[a]	0.231(0.099)[b]	0.303(0.648)[a]	0.227(0.080)[a]	0.030(0.087)[a]
Row Planting		0.135(0.871)	0.478(0.056)[a]	0.184(0.081)[b]	0.312(0.087)[a]
Fertilizer application			0.198(0.831)[b]	0.012(0.102)	0.215(0.111)[c]
Grading				0.331(0.072)[a]	0.325(0.079)[a]
Labelling					0.514(0.748)[a]
Likelihood ratio test [χ^2 (15) = 190.97]					
Joint probability (success)	0.140				
Joint probability (Failure)	0.037				
Linear predictions					
Certified seed	0.394				
Row planting	0.771				
Fertilizer Applications	0.681				
Grading (S&W)	0.129				
Labelling	0.286				
Collective marketing	0.457				

a, b and c represent 1%, 5% and 10% level of significance, respectively. Figures in parentheses are standard errors.

Fertilizer application and labelling, however, fall within two different categories of practices (GAPs and marketing access). The adoption of one, for instance labelling is not dependent on the adoption of the other, fertilizer application hence the smallest correlation coefficient recorded. The results further indicate that the joint probability of adopting all the technologies was 14% and the joint probability of failure to adopt all the technologies was 3.7%. The linear prediction as indicated in the Table 6.2 measures the probability of farmers adopting each of the GAPs and marketing strategies. From Table 6.2, the linear predictions show that the probability of households adopting certified seeds, row planting, fertilizer, grading, labelling and collective marketing are 39%, 77%, 68%, 13%, 29%, and 46% respectively.

6.2.2 Determinants of farmers' choice of farm and marketing strategies

The factors influencing adoption of the various components of the VC package using the MVP in equation [6] are presented in Table 6.3. The table presents the adoption equation for each of the GAPs and marketing strategies. Hence, we have six results. A positive coefficient in relation to a variable implies that as the variable increases, the probability of adoption of the component also increases. The reverse goes for a negative coefficient concerning a variable.

Table 6.3: Maximum likelihood estimation of the Multivariate Probit Model

	Certified seeds		*ROW*		*FZ*		*Labelling*		*Grading*		*CMKT*	
Variable	***Coeff***	***S.E***	***Coeff***	***S.E***	***Coeff***	***S.E***	***Coeff***	***S.E***	***Coeff***	***S.E***	***Coeff***	***S.E***
Household Characteristics												
Sex	0.194	0.13	0.336[a]	0.136	-0.001	0.197	0.032	0.161	0.206[c]	0.125	0.312[c]	0.173
Household Size	0.019[b]	0.01	0.001	0.009	0.024[c]	0.129	0.035[a]	0.01	0.016[c]	0.009	0.024[b]	0.011
Number of years in Crop Farming	-0.004	0.01	0.139[b]	0.006	0.018[b]	0.008	0.013[c]	0.007	0.145[b]	0.006	-0.004	0.006
Number of Years in Education	0.271[b]	0.13	0.67[a]	0.238	0.296	0.024	0.047[c]	0.027	0.381[c]	0.22	0.001	0.019
Household Assets												
Farm Size	0.766[b]	0.37	0.217[b]	0.106	0.062[c]	0.33	-0.011	0.111	0.004	0.006	0.029[c]	0.017
Off-farm Income	0.48[a]	0.15	-0.26	0.158	0.911[a]	0.199	0.459[a]	0.168	-0.03	0.143	0.467[c]	0.275
Own Donkey	0.634[b]	0.26	0.324	0.221	0.594[c]	0.322	-0.131	0.276	0.293	0.221	-0.239	0.273
Own Tricycle	-0.04	0.17	0.183	0.167	0.442[b]	0.201	0.196	0.203	-0.04	0.165	0.578[b]	0.263
Own TV/or Radio	0.036	0.16	0.598[a]	0.162	0.835[a]	0.215	0.083	0.203	-0.04	0.154	0.027	0.213
Institutional/Policy Variables												
Workshop Attendance	0.557[a]	0.14	-0.2	0.161	0.237	0.217	0.01	0.177	0.405[a]	0.14	-0.05	0.179
Demonstration Farms Visit	0.531[a]	0.14	0.509[a]	0.153	-0.547	0.212	0.283[c]	0.168	-0.16	0.132	-0.451[c]	0.169
Other Agricultural training received	-0.13	0.15	0.545[a]	0.16	-0.341	0.214	0.343[b]	0.167	0.376[a]	0.144	-0.402[b]	0.188
Membership of Social group	0.443[a]	0.13	0.292[b]	0.145[a]	0.591	0.215	0.071	0.165	0.407[a]	0.13	0.289[c]	0.171
Access to market information	0.520[a]	0.12	-0.240	0.134	0.063	0.184	0.459[a]	0.168	-0.060	0.126	0.408[b]	0.185
Access to storage facilities	0.164	0.12	0.459[a]	0.131	0.028	0.18	-0.233	0.147	0.534[a]	0.118	-0.087	0.160
Received Gov't extension services	0.298[b]	0.14	0.24	0.159	0.412[c]	0.219	-0.124	0.184	0.012	0.147	0.231	0.193
Location Variables												
Distance to the nearest Output Market	-0.001	0.002	0.001	0.002	0.852[a]	0.196	0.001	0.002	0.001	0.002	0.054[c]	0.299
Upper East	0.276[c]	0.170	0.279	0.165	1.619[a]	0.263	-0.124	0.479	0.479[a]	0.156	-0.313	0.207
Upper West	0.524[b]	0.191	2.151[a]	0.401	1.645[a]	0.423	-0.678[a]	0.261	1.121[a]	0.192	-0.676[b]	0.282
Constant	-1.64	0.40	-0.20	0.374	-0.839	0.522	-1.788	0.455	-0.81	0.363	-1.514	0.495

a, b and c indicate significance levels at 1%, 5% and 10% respectively. ROW, FZ and CMKT denote row planting, fertilizer application and collective marketing, respectively.
Source: Field Survey, 2016.

The estimates related to household characteristics indicate that male farmers are more likely to adopt row planting, more likely to have their produce graded before selling and have greater propensity to engage in collective marketing. Though marketing activities are usually undertaken by women, the type of marketing referred to is gathering of produce at the community/village level to be purchased by an off-taker. The household size variable is key in explaining the adoption of certified seeds, fertilizer application, labelling, grading and collective marketing. Families with large members serve as farm labour to combat the challenging labour intensive nature of agricultural technologies and marketing strategies. The positive correlation between household size and the use of fertilizer is contrary to a result obtained by Ahmed (2015) who established a negative relationship between large family size and fertilizer application. Farmers' level of experience measured by the number of years in crop farming is positively related to row planting, fertilizer application, labelling and engagement in collective marketing. Higher educational status increases farmers' awareness about the benefits of farm technology and marketing strategies (Ahmed, 2015; Gebresilassie and Bekele, 2015). From the results, education was found to have a positive relationship with the use of certified seeds, row planting, labelling and engagement in collective marketing. The relationship between education and certified seeds is consistent with the finding Shiferaw *et al.* (2014).

Household assets have been established to influence farmers' decisions on farm technology adoptions (Kassie *et al.*, 2013, Holden 2014). Contrary to the study of Kassie *et al.* (2015), the study found a positive relationship between certified seeds and farm size which is consistent with the findings of Shiferaw *et al.* (2014). Similarly, farm size has a positive relationship with row planting and fertilizer application. Off-farm activities also exhibit

positive correlation with the use of certified seeds, row planting, fertilizer application and collective marketing. This is plausible, as farmers often generate income from off-farm activities to support their farming activities in terms of purchasing inputs. Farmers' engagement in off-farm activities generates extra income that can be used to support the farm household in case of productivity failure or where farm products are not sold at the right time. Further, the results indicate that ownership of donkey increases the probability of certified seeds and fertilizer adoption. This result is consistent with previous studies on the use of farm technology (e.g. Priscilla *et al.*, 2014; Marenya and Barret, 2007). These studies reported that ownership of animals especially donkeys that are used for farm work significantly influence farmers' choice of technology. Similarly, ownership of tricycle and TV/or radio also do influence farmers' adoption of some components of USAID/ADVANCE VC package.

From the results presented in Table 6.3, workshop attendance, visits to demonstration farms and other agricultural related trainings received have a significant influence on smallholder farmers' choice of production technologies and marketing strategies. Di Falcao and Bulte (2013) and Kassie *et al.* (2013) reported that social capital and network variables are important in explaining households' adoption decisions. This is because attending farm workshops and visits to demonstration farms help increase farmers' knowledge and understanding of productive technologies and agricultural marketing strategies. Hence, farmers who are knowledgeable about productive technologies are more likely to adopt than those who do not know (Zhang *et al.*, 2002). Likewise, membership of farmers' group may increase access to information on productivity-enhancing technologies and marketing

strategies (Olwande and Mathenge, 2012). Hence, membership of farmers group is expected to increase adoption.

Similarly, access to information on input costs and output prices shape farmers' decision making, likewise, access to storage facilities. Extension service is an important variable that provides technical information to farmers. The extension service variable has a positive correlation with the use of certified seeds and fertilizer application. This finding is in line with Sisay *et al.* (2015) and Mmbando and Baiyeghunhi (2016), who found a positive relationship between a number of extension contacts and adoption of improved maize variety. Consistent with Shiferaw *et al.* (2014), location of smallholder farmers influences the adoption of agricultural technologies.

6.2.3 Determinants of Intensity of Adoption

Table 6.4 reports the determinants of the adoption of GAPs and marketing strategies from the basic Poisson and Negative Binomial regression analysis. The dependent variable is the number of GAPs and marketing strategies used by the farm households. The alpha coefficient value for the Negative Binomial is insignificant suggesting the non-existing of over-dispersion. Thus, the null hypothesis that the conditional mean and variance of the dependent variable are equal cannot be rejected. Also, the Vuong test result suggest that the standard Poison model is the best fit for describing the intensity of adoption as compared with zero-inflated Poisson at 5 percent level of significance. This indicates that the proportion of farm households who did not adopt any of the GAPs and marketing strategies (the number of zeros) is not in excess to affect the quality of the results. Though the estimated *Pseudo-*R^2 is quite low, the *Wald-Chi*^{2} value of 128.08 with 1 percent significant level is satisfactory (Mensah-Bonsu *et al.*, 2017)

Table 6.4: Poisson Regression Results

Variable	Poisson Regression		Negative Binomial	
	ME	***SE***	***ME***	***SE***
Household Characteristics				
Sex	0.074	0.045	0.069	0.056
Age	-0.007[a]	0.002	-0.007	0.003
Number of years in Education	0.022[b]	0.01	0.000	0.006
Number of Years in crop farming	0.001	0.004	0.002	0.003
Number of households in school	-0.745[b]	0.133	0.027	0.009
Household Assets				
Farm Size	0.027[a]	0.007	-0.002	0.003
Non-farm Income	-0.111[b]	0.056	-0.119	0.066
Ownership of Tricycle	0.274[a]	0.068	0.077	0.081
Ownership of motorbike	0.051	0.048	0.051	0.061
Institutional Variables				
Workshop Attendance	0.111[c]	0.067	0.000	0.051
Visit to demonstration Farms	0.067[c]	0.039		
Access to market information	0.062	0.042	0.078	0.055
Received Gov't extension services	0.379[a]	0.084	0.049	0.065
Location Variables				
Upper East Region	0.269[a]	0.06	0.266	0.065
Upper West Region	0.351[a]	0.06	0.340	0.077
Constant	0.779[a]	0.10	0.794	0.123
Ln(alpha)			-9.162	3.864
Alpha			0.002	0.016
Wald Chi^2 (15)	128.08			
Prob > Chi^2	0.000			
Pseudo R2				
Log Pseudolikelihood				
Observation	720			
Voung test of ZIP vrs Basic Poisson: z =2.35; Pr >z =0.0018				

a, b and c indicate significance levels at 1%, 5% and 10% respectively.
Source: Field Survey, 2016.

The results from Table 6.4 indicate a negative relationship between age and the likelihood to adopt more of the given set of technologies. This is plausible because farmers are usually reluctant to try new ways of doing things as they grow old, whereas the young ones are more willing to take the risk associated with innovations. The positive and significant education variable suggests that as farmers become more educated, they increase the intensity of adoption of a given farm management strategy and marketing technologies. This is because educated farmers are more likely to access, comprehend and absorb information given to them by the agents of the intervention programmes or extension service personnel. Educated people are 2.2% more likely to increase their intensity of adoption than non-educated and its significant at 5%. This finding is consistent with that of Ehiakpor *et al.* (2016). With regard to farm size, the findings indicate that farmers with large farm size are 2.7% more likely to adopt more of the GAPs and marketing strategies than farmers with smaller farm size. This is because the coefficients of the farm size variable is positive and significant at 1%. This result is consistent with previous adoption and farm marketing studies (e.g., Ahmed, 2015, Teklewood *et al.,* 2013; Kassie *et al.,* 2013). Engagement in non-farm income is negatively signed and significant at the 5% level. The negative sign of the non-farm income suggests that as farmers take more time off their farming activities, the number of farm management and marketing practices used is likely to decline at 11.1% compared to those who do not engage in non-farm income activities. It also means that they do not invest their non- income into the farming operations to increase the intensity of adoption of the farm management and marketing practices. However, ownership of tricycle increases the intensity of adoption.

The positive and significant effect of workshop attendance suggests that exposing farmers to workshop activities where they learn and share ideas about farm activities will help increase adoption of more farm management and marketing strategies to boost production and farm income. Likewise, visits to demonstration farms where farmers get the opportunity to observe and practice farm management technologies increase their knowledge about such technologies, hence, increases the intensity of adoption. The likelihood of workshop attendance and visit to demonstration farms to increase intensity of adoption of the practices is 11.1% and 6.7% at 10% each respectively. Another important result is the positive and significant effect of extension services on the number of farm and marketing practices adopted and hence the intensity of adoption. Farmers who received extension services are 37.9% more likely to increase the intensity of adoption of the farm and marketing practices than those who do not receive government extension services. This occurs at 1% level of significance. Location variables are positive and significant suggesting the farmers located in the Upper East and Upper West regions, where rice and maize respectively are dominant, adopt more of the farm management practices and marketing strategies than those from the Northern region[10].

6.2.3.1 Impact of USAID/ADVANCE Intervention Programme on Beneficiaries' Welfare

Before turning to the impacts of participating in the USAID/ADVANCE programme, the study first discusses the quality of the matching process. After estimating the propensity scores for USAID/ADVANCE participants and non-participants, each of the participants was matched to one or several non-participants according to their socioeconomic characteristics such as age and educational status. This is done to eliminate any significant

[10] Northern region was used as a base category for location variables.

differences between participants and non-participants based on their characteristics, so that the only difference between them is the effect of participation in the USAID/ADVANCE programme. In this case, we say the participants and non-participants are subjected to the condition of common support or confined in the region of common support. However, those that do not get their match are considered to be off-support. Figure 6.1 gives a density distribution of the propensity scores and the region of common support. The green colour indicates a group of participants (ADVANCE) who did not get their match from the control group (non-participants). The maroon and the blue indicate the treated and the control farmers who were perfectly matched. It is clear from Figure 6.1 that there is a considerable overlap of distribution of the propensity scores for both the participants and non-participants of the USAID/ADVANCE programme. Thus, the common support assumption is satisfied with a loss of only 16 (4.06%) from the treated group. The bottom half of the graph represents the distribution of the estimated propensity scores for the non-participants and the upper half refers to the participants. The estimated densities of the scores are on the *y-axis.*

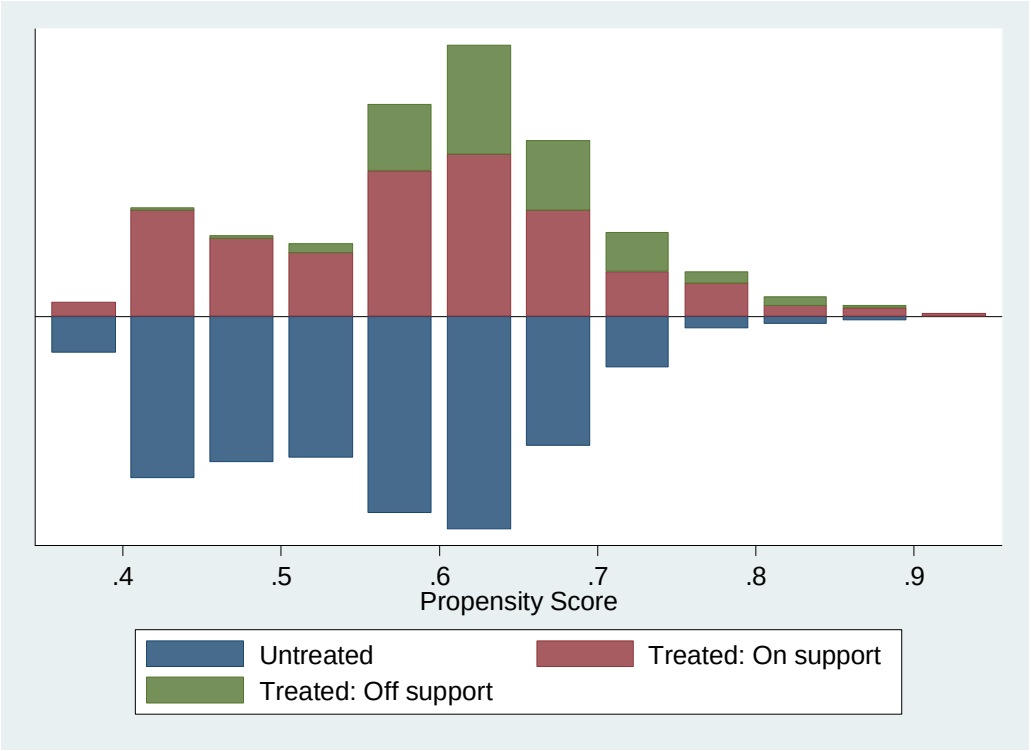

Figure 6.1: Propensity score matching between treated (USAID/ADAVANCE members) and untreated (non-USAID/ADVANCE members)

A major aim of the propensity score is to balance the distribution of the variables between ADVANCE participants and non-participants. Table 6.5 presents the results of the matching quality from the covariates balancing test between participants and non-participants. The table indicates that, the standardized mean difference used in propensity (about 21% before matching) dropped considerably to 4.8% - 5.7% after matching leading to a substantial reduction in the total bias, in the range of 73% - 78%. The p-values of the likelihood ratio tests indicates that the joint significance of the covariates was not rejected before matching but was rejected after matching in all the matching technique.

Table 6.5: PSM quality indicators before and after matching

Matching Algorithm	Pseudo R^2 before matching	Pseudo R^2 after matching	LR χ^2 (p-value) before matching	LR χ^2 (p-value) after matching	Mean standardized bias before matching	Mean standardized bias after matching	Total % bias reduction
NNM	0.331	0.031	30.33 (0.000)	1.36 (0.986)	21.1	5.7	72.98%
KBM	0.331	0.029	30.33 (0.000)	1.16 (0.891)	21.1	4.8	77.25%
RBM	0.331	0.022	30.33 (0.000)	1.27 (0.811)	21.1	5.1	75.83%

NNN = Five nearest neighbor matching with replacement and common support KBM = Kernel based matching with band width 0.05 and common support. RBM = Radius Matching with a radius of 0.001 and common support

The Pseudo R^2 also reduced significantly from 0.33 before matching to about 0.022-0.031. The low Pseudo R^2, low mean standardized bias, high total bias reduction and the insignificant value of the likelihood ratio tests suggest a fair balancing of the distribution of the covariates between ADVANCE participants and non-participants. Thus, both groups have the same distribution in covariates after matching (Mmbando *et al.*, 2015). The results, therefore, suggest that the proposed specification is fairly successful and can therefore be used to estimate the impact of the USAID/ADVANCE programme among households with similar characteristics.

6.2.4 The Average Impacts of ADVANCE Programme on the Participants - ATT

The estimated average impact of USAID/ADVANCE programme participation on household welfare is presented in table 6.6. The study used farm income per acre, household income and consumption expenditure per capita as welfare indicators. Both the Nearest Neighbor and the Kernel Matching techniques were used to test the robustness of the results. The PSM estimates in the table show that smallholder farmers who participated

in the USAID/ADVANCE programme had increased their farm and household income and consumption per capita.

Table 6.6: Impact of ADVANCE Programme on Farm Income Per Acre, Household Income, and Consumption Expenditure per Capita

Outcome Variable	*Matching algorithm*	*Mean Outcome Variables based on Matched Observations*		
		Participants	*Non-participants*	*Difference (ATT)*
Farm Income per acre	NNM	924.325	551.244	375 (3.13)[a]
	KBM	958.330	550.179	408 (3.73)[a]
	RBM	937.971	548.651	389 (3.27)[a]
Household Income	NNM	8,603.212	4179.085	4,424 (5.85)[a]
	KBM	8,501.986	4150.208	4,351 (6.22)[a]
	RBM	8,565.405	4209.021	4356 (4.91)[a]
Consumption Expenditure per capita	NNM	893.926	463.869	430.057 (4.51)[a]
	KBM	870.197	454.989	415.209 (4.72)[a]
	RBM	865.895	448.816	417.079 (4.82)[a]

1: Figures are in Ghana Cedis (GH¢) 2: 1US$ = 4.08 (average rate for 2016) 3: a represents significant level at 1%.

The expected impact of the ADVANCE programme on farm income per acre varies from GH¢375 ($91.91) to GH¢ 408 ($100) depending on the matching algorithm. Thus, USAID/ADVANCE beneficiaries get between GH¢375 ($91.91) and GH¢ 408 more incomes per acre of farm output compared with the non-participants. The results could be ascribed to the fact that participants in the programme may have better market opportunities with regards to access and prices for their products, and consequently higher incomes. For instance, the collective marketing allows farmers to aggregate their products together and sell in bulk to the bigger off-takers such as Vestor oil, Premier Foods Industry Limited, Avnash industries among others. This is also make them more attractive to individual aggregators as well, and hence, achieve higher income levels compared with the non-

participants. Similarly, participation in USAID/ADVANCE programme increased average household income in the range of GH¢4,351($1,066.42) and GH¢4,424 ($1,084.31). This also implies that participants would have lost an average household income in the range of GH¢4,351($1,066.42) to GH¢4,424 ($1,084.31) if they had not participated. Thus, participating in the ADVANCE programme have spillover effects on other sources of household income other than income from farm, hence, its impact on total household income. This finding is consistent with the findings of Bellemare (2012) who showed that participating in contract farming increases household income Madagascar. The results further indicate that farmers' expenditure per capita increased in the range of GH¢415 ($101.72) to GH¢430 ($105.39) through participation in the USAID/ADVANCE programme. Thus, the USAID/ADVANCE programme has had a substantial effect on the welfare of the participating smallholder farmers.

6.2.5 Sensitivity of the ATT to Hidden Biases

In PSM, one of the most critical shortfalls is the underlying assumption that individuals are selected into the treated group based on observed characteristics (Rubin, 1974; Rosabaum, 1983; Rosabaum, 2002). As a result, the matching estimates may not be robust to hidden biases due to unobserved characteristics (Caliendo and Kopeinig, 2008). The study, therefore, applied the *rbound* test technique suggested by Rosenbaum (2002) to check if the estimates obtained from the PSM are robust to the strong assumption of CIA. The rbounds test is used to examine the possibility of the presence of unobserved confounders that is likely to biased the estimates from the PSM. The *rbound* test result is presented in table 6.7.

Table 6.7: Robustness of ATT estimates based on unobserved heterogeneity – rbounds test

Gamma	*sig+*	*sig-*	*t-hat+*	*t-hat-*
1.0	0	0.000	-320.063	-320.063
1.5	0	0.000	-420.647	-217.870
2.0	0	0.000	-489.274	-142.443
2.5	0	0.024	-543.760	-81.569
3.0	0	0.223	-586.383	-31.729
3.5	0	0.605	-623.508	12.238
4.0	0	0.876	-655.679	51.116
4.5	0	0.974	-686.364	85.163
5.0	0	0.996	-713.380	117.716

Note: gamma = log odds of differential assignment due to unobserved factors; +sig = upper bound significance level; -sig = lower bound significance level; t-hat+ = upper bound Hodges-Lehmann point estimate; t-hat− = lower bound Hodges-Lehmann point estimate.

The results from the *rbound* test indicate that the positive and the significant impact of ADVANCE-USAID intervention programme on the welfare of the smallholder farmers is not sensitive to hidden characteristics. This is because the positive impact of the programme estimated from the PSM would only change at bound statistic 3.0 as indicated in the Table. Thus, it would require 200% to reverse the conclusion that ADVANCE-USAID intervention programme had a positive and significant impact on farmers' welfare. Therefore, the positive impact of the programme is not overstated.

6.3 Effects of heterogeneity among USAID-ADVANCE intervention programme

One of the drawbacks in the estimation of the *ATT* is that PSM assumes a common causal effect across the treated group. Thus, there is no variation in the impact of the programme with regard to the outcome variables. However, the impact may differ among the households in the treatment group due to different demographic, farm-specific and institutional factors. For instance, Danso-Abbeam (2018), Ma and Abdulai (2016), and

Abebaw and Haile (2013), have documented the presence of heterogeneity among treated groups. Worssen *et al*. (2017) indicated that estimating the differential effects among USAID-ADVANCE programme participants is critical for targeting households and designing "best fit" approach rather than "one size fits all" approach. The study, therefore, estimated the heterogenous effects of USAID-ADVANCE intervention programme across the demographic, farm-specific and institutional variables with respect to two key welfare indicators (consumption expenditure per capita and farm income per acre). An OLS estimator was employed to estimate the causal effect of heterogeneity of the treatment assignment. The results are reported in Table 6.8. From the OLS results, both models are free from multicollinearity as the Variance Inflation Factor (VIF) mean value of 1.44 is less than 10. Gujarati and Sangeetha (2009) indicated that if the VIF of each explanatory variable is less 10, then multicollinearity is absent in the model.

The results from Table 6.8 indicate that participating in the USAID-ADVANCE programme increases consumption expenditure per capita and Farm income per acre among males than females' respondents. In West Africa in general, and Ghana in particular, men are usually the owners of productive resources such as land, and therefore have access to information than women. Thus, households headed by men have a higher probability of benefiting from such intervention programme than women due to their social and cultural power. Participation have negative effects for the aged farmers with regards to the outcome indicators, consumption expenditure per capita and farm income per acre. Thus, the young farmers tend to benefit more from participating in the programme. This is because the youth are energetic and ready to engage in innovative activities as compared with the aged who usually want to rely on their long-standing experience, and hence glued

to old methods of farming (Islam *et al*., 2012). The study also found negative statistically significant heterogenous effects of participation for household size. Thus, on the average, participating households with smaller family size have higher consumption expenditure per capita and farm income per acre. Worssen *et al*. (2017) estimated a contrary heterogenous effects of extension access on asset ownership which is an indicator of welfare. Similarly, number of years in crop farming (experience) is positive and statistically significant for the two welfare indicators, suggesting that participating in the programme exert a larger effect for farmers with longer years of experience.

Table 6.8: Heterogenous Effects among beneficiaries of USAID-ADVANCE Intervention Programme

	Cons. Exp./capita		***Farm income/acre***	
Variables	***Coef.***	***Robust Std. Err.***	***Coef.***	***Robust Std. Err***
Sex	0.2110[b]	0.1026	0.0863[c]	0.0512
Age	-0.0139[a]	0.0044	-0.0089[a]	0.0022
Marital Status	0.0999	0.1380	0.0540	0.0688
Household size	-0.0613[a]	0.0064	-0.0062[c]	0.0032
Years in Crop farming	0.0114[b]	0.0045	0.0082[a]	0.0023
Formal Education	-0.0020	0.0113	-0.0076	0.0056
Non-farm income participation	-0.1141	0.1279	-0.1243[c]	0.0637
Ownership of tricycle	0.2244[b]	0.1092	0.1077[b]	0.0544
Workshop attendance	0.0575	0.1062	0.0709	0.0529
Demonstration farm visits	-0.1096	0.0979	-0.0520	0.0488
Received Agric - related training	0.1748[c]	0.1009	0.0924[c]	0.0503
Received extension advice	0.2145	0.1344	0.0790	0.0670
Constant	6.1771	0.2402	3.2334	0.1197
F-test	9.40[a]		3.91[a]	
R-squared	0.6438		0.6182	
Adjusted R-squared	0.6179		0.5879	
VIF	1.47		1.47	

The dependent variable is the ATT of the welfare indicators (consumption expenditure per capita and farm income per acre. a, b, and c denote significance levels at 1%, 5% and 10%, respectively.

Treated households who engages in non-farm economic activities such as trading and salaried employment, benefit more from the intervention than those without any source of income from non-farm economic activities.

The results further emphasize that households with farm productive asset such as tricycle benefit most from the intervention programme. Finally, the study found a positive and statistically significant heterogenous influence of participation in the intervention programme among treated households who have received agricultural-related training such as farm financial management, farm as a business, among others.

6.4 Implication of the Agricultural Household model on welfare

It must be recognized that, although agricultural household models, were not directly employed in this study, they are the relevant theoretical framework for assessing an intervention programme in developing economies as agricultural farm household form the study's unit of analysis. This is because the agricultural households' main objective is the maximization of welfare subject to constraints. Thus, farm households participating in an intervention programme like ADVANCE or adopting certain practices to increase yield is simply not an end in itself but a means to enhance their welfare/consumption and achieve utility maximization (Donkoh, 2006). With reference to Fig. 6.2 (adapted from Donkoh, 2006), PPF_1 ,depicts the production frontier for the conventional/non-participants in the ADVANCE project. The utility is therefore maximized at point E_1 where slope of the PPF_1 and indifference curve I_1 are the same. With the participation and adoption of the GAPs and marketing strategies promoted by ADVANCE, we assume a neutral shift of the PPF_1 to PPF_2 for a new equilibrium to be established at E_2. At this new equilibrium, output and

consumption are higher. This is in line with the observed increased in farm income per acre, household income and consumption expenditure per capita attained by the ADVANCE participants in the PSM estimation. Besides, households can enjoy more leisure and produce more because of the existence of markets.

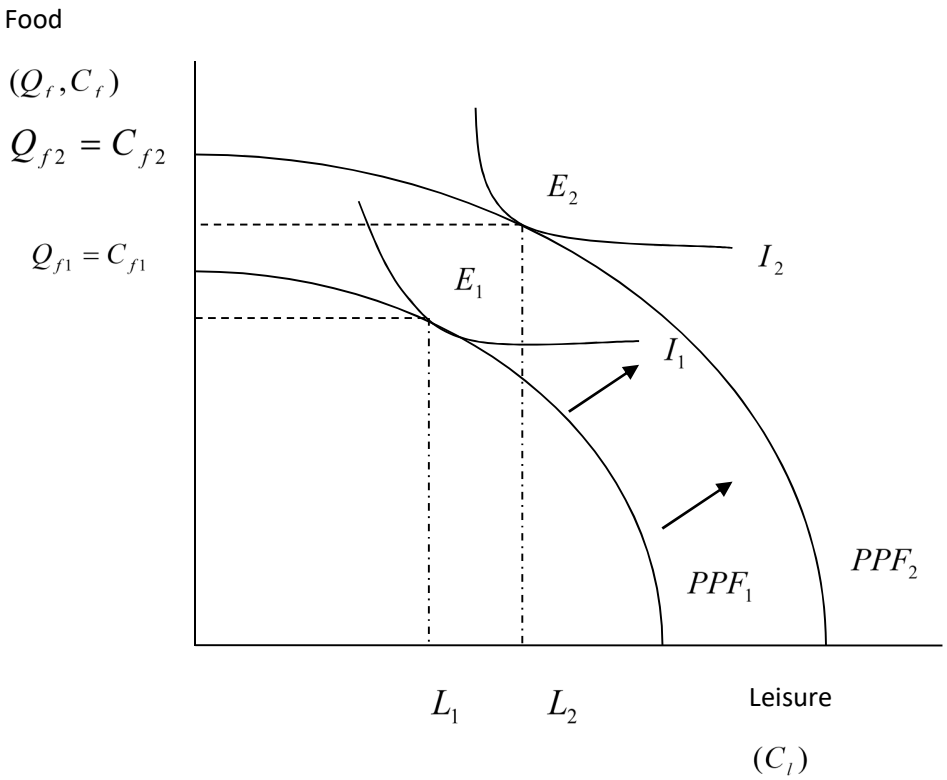

Figure 6.2: Effect of technology on farm income per acre, household income and consumption expenditure per capita
Source: Adapted from Donkoh (2006)

CHAPTER SEVEN

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary

In spite of the significant contributions of agriculture to the rural farm economy and the macroeconomic balances, the sector is plagued with numerous challenges. One of the critical challenges is the low yields of crops observed by smallholder farmers who produce about 90% of the Ghanaian agriculture output. As a result, the pursuit to increase crop productivity and subsequently enhance the welfare of the rural farm families has been the focus of government and many other international and local NGOs. One of the prominent international agencies that has funded many agricultural related programmes is USAID. USAID, through ADVANCE, implemented an agricultural programme to boost the productivity of farm households. One of such programmes that this study focused on is the training programmes that sought to build the capacity of farmers on Good Agricultural Practices (GAPs), specifically on row planting, use of improved crop varieties and fertilizer application and marketing strategies, specifically sorting and grading, labelling and group marketing. The study analysed the impact of the USAID/ADVANCE programme on the welfare of the beneficiaries as its general objective. The specific objectives and methodology used to achieve the results are as follows:

First, the study documents the adoption situation of the components of the GAPs (row planting, use of improved crop variety, and fertilizer application) and marketing strategies (sorting and grading, labelling and group marketing). It used descriptive statistics such as percentages, means and charts to describe the adoption situations of each component of the GAPs and marketing strategies. The study also performed regional comparative analysis

with regard to the adoption situations. Further, yields of rice, maize and soybean were compared with regards to the study areas (Northern, Upper East and Upper West regions).

Second, the determinants of the farmers' participation were examined using binary probit model due to the dummy nature of the response ("yes" if participation; 0 otherwise) while multivariate probit model (MVP) was used to model the simultaneous adoption decisions of GAPs and marketing strategies as well as to examine whether there is inter-relationship among the GAPs and marketing strategies.

Third, count data models, specifically Poisson and Negative Binomial, were used to identify the determinants of the intensity of adoption of GAPs and marketing strategies. Count data models are most appropriate because the dependent variable (intensity of adoption) is a numerical count by its nature. Given that there is a random occurrence of the number of components in the package used by the farmer, the appropriate probability distribution is the Poisson distribution.

Finally, the impact of the intervention programme on the participating farm households was critically analysed using PSM procedure which is one of the rigorous impact evaluation techniques used in non-experimental impact assessment. To check the robustness of the results obtained from the PSM, a doubly-robust estimation technique called IPWRA was employed. The results and discussion of these methodologies used in achieving the specific objectives of the study are contained in chapters 5 and 6. The conclusions drawn from the results are briefly presented in the next section.

7.2 Conclusions

The study has analyzed adoption and intensity of GAPs and marketing strategies by smallholder farmers in the former three northern regions of Ghana using household level data of 673 farm households. It has also assessed the impact of the USAID/ADVANCE intervention programme on the welfare of the beneficiaries using farm income per acre, household income, and consumption expenditure per capita as welfare indicators. The study revealed that about 54%, 76% and 93% of USAID/ADVANCE farmers across the former three northern regions had adopted certified seeds, row planting, and fertilizer, respectively. The relatively high adoption of GAPs by project beneficiaries would address the needs (e.g. low productivity) of the participants by increasing productivity of the commodities hence income per acre.. The adoption rates, however, are generally higher among USAID/ADVANCE farmers in the Upper East region, particularly in maize and rice fields, than their counterparts in the Northern and Upper West regions. This means that whiles farmers in the Upper East region were focused on increasing productivity their counterparts in the Northern and Upper West were concerned about expansionary measures. This is evident in the low yield figures recorded in these two regions but with the largest number of acreages put under cultivation for the three commodities, particularly with respect to the Northern region. Adoption of certified seeds of soybean is relatively low across all the regions, whereas only 3.3% USAID/ADVANCE farmers applied fertilizer on their soybean fields. The continuous low adoption of improved soybean seeds coupled with low soil fertility of the soil and non-adoption of fertilizer will lead to low productivity of the crop and is of no surprise that the current yield of soy is 1.7mt/ha (MoFA, 2017). The adoption of marketing strategies is low in all the three crops across the

three regions. The average adoption rates of product labelling, grading, and collective marketing for USAID/ADVANCE members across the three regions are 48%, 13%, and 12%, respectively. The low adoption rates of the marketing practices imply that the participants are mostly subsistence farmers or at best semi-subsistence hence are not ready to produce for commercial purposes but mainly for consumption purposes.

The results from the MVP analysis of the study indicated that all the selected components of GAPs and marketing strategies were found to be complementary and that the adoption of a particular GAP is conditioned on the adoption of the other GAPs. This means that the practices are related and must be taken on board together. Moreover, different socio-economic factors (sex, household size, the number of years in crop farming, educational attainment) had significant influence on adoption of the different components of GAPs and marketing strategies. Thus, the socio-economic factors particularly education and sex must be taken into consideration in designing and implementing similar projects in future in an attempt to solve the root causes (e.g. inadequate extension) of low productivity and market access. Household assets (off-farm income, ownership of donkeys, tricycle/motor bike and TV/radio) were found to have significant influence on different components of GAPs and marketing strategies. Thus, ownership of household assets are necessary impetus to the adoption of the practices and that the project is not pro-poor enough to enable adoption/participation by the very poor. More importantly, institutional factors (demonstration farm visits, access to market information, access to storage facilities and extension services) and social capital and networking (e.g. Farmer Based Organizations-FBOs) have positive significant effects on adoption of different components of GAPs and marketing strategies. The findings also revealed that adoption intensity (number of GAPs

and marketing strategies adopted by individual farm household) is also positively influenced by factors such as farmers' educational level, ownership of tricycle, workshop attendance, demonstration farm visits and farmers' contact with extension services. This suggests that the number of practices adopted hinges on some socio-economic variables, asset ownership and policy variables that must be considered in project design and implementation to successfully address the underlying causes (of poverty, extension credit) of farmers' challenges in order to increase productivity, enhance market access and welfare of project participants.

Finally, the results from the impact analysis show that participating in the USAID/ADVANCE intervention programme has a significantly positive effect, both statistically and economically, on farm income per acre, household income and consumption expenditure per capita. Thus, participation in the intervention programmes such as USAID/ADVANCE enhances welfare for the project participants.

7.3 Recommendations

Some key lessons have emerged from this study for government and other stakeholders in the Ghanaian agricultural sector. First of all, the yields were relatively low, particularly for maize and rice, compared to yields of other countries such as Brazil, a country that is setting the vision to become a global agricultural powerhouse. The yields of rice and maize in Brazil have been estimated to be about 4,704kg/ha and 4,706kg/ha, respectively. This offers a milieu for a holistic approach to increasing productivity in a sustainable manner to improve the livelihoods of the farmers in these sectors. To achieve a sustained gain from investment in interventions programmes and uplift the living standards of the rural farm

households, it is imperative to think holistically about socioeconomic development in a more comprehensive way. For instance, the study revealed that educated farmers adopt more of the GAPs and marketing strategies than the non-educated farmers. We believe that long-term investment in education can serve as a vehicle for increasing agricultural productivity in a more sustainable way. The study envisages education in two perspectives. First, formal education, where young people are empowered and encouraged to go into agriculture. The ongoing youth in agricultural programme implemented by state institutions such as COCOBOD, the Youth Employment Agency and MoFA through the current "Planting for Food and Jobs" and "Rearing for Food and Jobs" programmes as well as other programmes by international organizations such as SOLIDARIDAD should be strengthened to the letter. Secondly, non-formal adult education where at least numeracy is taught could be integrated into intervention programmes or strengthened where it already exists. This would shape the decision-making and choice frameworks. It is expected that these efforts will have direct positive effects on farm income, help young people to journey their way out of poverty, and improve the decision-making process of the adults, especially in the study area where poverty is pervasive.

Also, from the study, access to market information and storage facilities have positive and significant effects on adoption of different components of the GAPs and marketing strategies. This simply suggests that focusing solely on productivity-enhancing technology transfer with little long-term development in agricultural infrastructure such as storage facilities will produce less than expected results from the huge investments in intervention programmes. Long-term infrastructural developments such as storage facilities are particularly important to assure farmers that if they experienced market surpluses, produce

could be stored in safer places for the next marketing seasons. To this end, strategies of buffer stocks or warehousing receipt system being implemented should be intensified. Since farmers with access to market information are likely to increase their adoption and adoption intensity of GAPs and marketing strategies it is suggested that a well-coordinated communication of market information system be integrated in agricultural value chain programmes/projects. This would enhance productivity and thus, increase farmers' income.

Also, the promotion and facilitation of farmers' group/association would help increase the use of GAPs and marketing strategies as these helps reinforce farmer-to-farmer extension services. The nucleus-outgrower farmer scheme where a nucleus farmer serves as an aggregator for smallholder farmers is commendable. Further, on-farm trials or demonstrations farms as a way of enhancing famers' technical skills should also be intensified across all agricultural sectors. Farmers who participate in demonstration farms get sufficient information on farm technologies as they learn more by practicing, hence, boost their farm productivity. The study also revealed the importance of extension services in the use of farm and marketing strategies. Therefore, government and other stakeholder extension delivery services should be strengthened through recruitment, incentives and regular training of the extension agents. It is strongly recommended for technology to be deployed in extension delivery so as to safe cost and limit the time expended during extension delivery services. Nucleus farmers with large acreage of farms and outgrowers should be encouraged to employ extension officers who would assist them and their out-growers.

Overall, this study argues for a comprehensive and a broader approach to improving the welfare of the rural livelihoods in the study area through infrastructural, agricultural technology transfer and support, and agricultural marketing strategy developments. It is also recommended that organizations, such as ADVANCE, implementing farm intervention programmes extend their coverage areas to capture more farmers, since the empirical evidence presented in this study shows that the programme led to improved welfare of farmers.

7.4 Limitation of the study

This study used the rigorous state-of-the-art econometric techniques to draw important conclusions. However, there are some limitations which are worth mentioning. First, the study covered ten districts in the former three northern regions only to draw general conclusions. These conclusions may be limited in a way as two (rice and maize) of the three crops are widely produced across the country. For instance, currently Volta region is the leading producer of rice but was not included in the sampling of the study because of resource constraint. The study, therefore, suggests that future studies can consider a nationwide survey. Second, it examines value chain development programmes of the ADVANCE project and focuses mostly on producers. However, the agricultural value chain constitutes a wide range of actors, from producers through aggregators, wholesalers and retailers to final consumers. Irrespective of its narrow scope regarding the value chain, the results are very insightful for policy implications since farmers who are the main focus of the study form the foundation of agricultural value chain.

Third, the results of the study hinge on the available cross-sectional data, and of the key findings may be affected by previous agro-climatic and economic situations such as market prices of inputs and outputs in the country. Using panel data may be more appropriate in drawing conclusions for policy implications as it would capture long-term effects and reduce hidden biases that may result from time invariant variables. Klevmarken (1989) noted that studies with cross-sectional data do not adequately account for unobserved heterogeneity and have the possibilities of obtaining biased estimates. Future studies with panel data are highly recommended to give further evidence on the impact of intervention programmes on the farmers' welfare.

Finally, the study did not assess the impact of ADVANCE intervention programme with regard to gender dimensions which, of course is a global issue. Similar studies can consider whether households headed by females benefit more from such intervention programme as against households headed by males or outperform them in the adoption of the GAPs and marketing strategies.

7.5 Contribution to Knowledge

According to Rugg (2004), there are four main ways by which a PhD research can contribute to the body of knowledge, namely:

- Your area of research-location
- Methods Used-Questionnaire, focus group, observations etc
- Solving trending issues
- Developing a Unique approach.

The study therefore attempts to situate some of its contributions to knowledge as suggested by Rugg (2004).

- USAID has implemented a number of agricultural development programmes (e.g. Ghana Agriculture Technology Transfer Project (ATT), Ghana Commercial Agriculture project (GCAP), Financing Ghanaian Agriculture Project (Fin-GAP)) over the years so has ACDEP facilitation of intervention programmes since 2004 when the pioneering work in agricultural value chains was implemented in northern Ghana. To the best of the researcher's knowledge, none so far has been subjected to a rigorous quantitative approach or econometric modelling such as this as opposed to the purely descriptive presentations of findings at the end of project (s) by evaluators and NGOs. Besides, NGOs and evaluators do not engage the kind of sample size and the spread considered in this study.

- The present policy of government of Ghana in Agriculture is aimed at achieving self-sufficiency in rice production, maintain self-sufficiency in maize production and increase the production of soybean for the purposes of food and nutritional securities. This has attracted intervention programmes such as PFJ, RFJ and PERD. This research has highlighted the critical variables policy designers need to trigger to enhance farmer participation in such programmes and subsequent implication on farmers' welfare.

- Donor interventions abound in the former three northern regions, compared to other parts of the country yet there is pervasive/abject poverty. This research has provided information to development practitioners to focus on the root causes of low productivity and markets access in the design of future projects.

8.0 PUBLICATIONS AND CONFERENCES

The following publication and conference presentation emanated from the research presented in this thesis

Book Chapter

Ehiakpor, S. D., Donkoh, A. S., and Amikuzuno, J. (2018). The welfare Impact of ADVANCE-USAID Intervention Programme: Evidence from ACDEP Facilitation in Northern Ghana In Alhassan, A., Agbenorhevi, M. and Ibrahim, A. (Eds), Agriculture in Ghana Today: Some Critical Topics for Policy Making, pp. 35-56. ISBN: 97-9988-2-8844-0

Conference

Ehiakpor, D.S., Donkoh, A. S., and Amikuzuno, J. (2017). The welfare Impact of ADVANCE-USAID Intervention Programme: Evidence from ACDEP Facilitation in Northern Ghana. A presentation of findings of USAID/APSP commissioned research at Agricultural Policy Research Summit, 15th August, 2017, Movenpick Hotel, Accra.

Ehiakpor, D.S., Donkoh, A. S., and Amikuzuno, J. (2020). The Determinants and Perceived Welfare Impact of USAID/ADVANCE Intervention Programme in Northern Ghana. A presentation at the 2nd International Conference on Irrigation and Agricultural Development (IRAD), 25th – 27th February, 2020, UDS International Conference Center, Tamale.

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10.0 APPENDICES

APENDIX I

Results of Variance inflation factor of the heterogenous effects in Table 6.8

VIF for the farm per acre and consumption expenditure per capita

Variable	VIF	1/VIF	Variable	VIF	1/VIF
Age	1.76	0.568917	Age	1.76	0.568868
YrsCF	1.75	0.572348	YrsCF	1.74	0.573085
OFFM	1.68	0.595002	OFFM	1.69	0.591873
WKSP	1.58	0.632290	WKSP	1.59	0.630031
EXT	1.56	0.641430	EXT	1.57	0.635880
AgTR	1.50	0.665702	AgTR	1.50	0.664668
DEMOS	1.38	0.725536	DEMOS	1.38	0.724871
Sex	1.19	0.843017	Sex	1.19	0.843191
MKG	1.15	0.872569	MKG	1.15	0.868829
EduYrsHHH	1.11	0.901593	EduYrsHHH	1.11	0.901879
MS	1.07	0.934548	MS	1.07	0.934507
TotFS	1.07	0.937055	TotFS	1.07	0.937124
HHS	1.06	0.946492	HHS	1.06	0.946590
Mean VIF	1.37		Mean VIF	1.38	

Appendix 2: Questionnaire

DATA COLLECTION INSTRUMENT

ACDEP/APSP/UDS COLLABOURATION QUESTIONNAIRE

RESEARCH TOPIC: THE WELFARE IMPACT OF USAID-ADVANCE INTERVENTION PROGRAMME: EVIDENCE OF ACDEP FACILITATION IN IN NORTHERN GHANA

Serial Number of Questionnaire ……

Introduction and Consent

Please introduce yourself to respondent: My name is_____I am an enumerator collecting data on behalf of ACDEP/APSP/UDS for the purposes of research. The questionnaire is to solicit information on analyzing "**The welfare impact of USAID-ADVANCE intervention programme: Evidence from ACDEP facilitation in northern Ghana**". All information provided will be treated anonymous and confidential and will be used solely for the purpose of this study. Your name would not be mentioned anywhere in the research work. Therefore, try as much as possible to be accurate and objective in your responses.

Please, you are free to interrupt me and ask for any clarification during the process of the interview. You have the liberty or legal right to call the principal researcher (Dennis Sedem Ehiakpor) on the mobile number +233244545181 and ask for any clarification at any point in time. I respect all the responses you give and appreciate your cooperation.

Your decision to participate in this interview is voluntary. The interview will take about ……

Are you willing to participate in the interview?

A. CONTACT INFORMATION ON ENUMERATORS AND RESPONDENTS

Enumerator's Information		*Respondent's Information*			
Name of enumerator		Phone #		Community name	
Contact mobile number		House #		Name of district	
Enumerator's Code		Household name		Name of region	
		Date:			

SECTION A. SOCIOECONOMIC CHARACTERISTICS OF RESPONDENTS

1. Household Basic Characteristics

Questions	*Responses*
1.1 Are you the household head?	(1) Yes [ ] (2) No [ ]
1.2 If no, state your relationship with the household head	(1) Spouse [ ] (2) Child/House-help (3) Farm care-taker [ ] others [ ] …..
1.3 Age of household head/respondent	
1.4 Gender of household head/respondent	(1) Male [ ] (2) Female [ ]
1.5 Marital status of household head/respondent	(1) Married [ ] (2) Single [ ] (3)Separated/divorced [ ]
1.6 Household (HH) size	
1.7 Household composition by Gender	(1) # of males ……. (2) # of females ……
1.8 # of people in the household in the following age category.	(1) < 18 … (2) 18 – 60 ……. (3) > 60……
1.10 # of years in crop farming	
1.11 # of years in rice farming	
1.12 # of years in maize farming	
1.13 # of years in soybean farming	

Note: Household consist of a group of people who live together, not necessarily in the same building; who usually eat from the same pot; and who pool their incomes and other resources to purchase or produce food. A household member is any person who, in the past 12 months, has lived with the household for at least 6 months regardless of whether they have intentions to stay or not. It includes any person attending school away from home, newly born babies, persons who are newly wedded into the household, person who have stayed for less than 6 months but have come to stay with the household.

2. Educational Status (Human Capital)

Questions	*Responses*
2.1 Can the household head (HHH) read, construct and write a simple sentence in English?	(1) Yes [ ] (2) No [ ]
2.2 Highest level of education completed by the household head	(1) Primary school [ ] (2) JHS/MSLC [ ] (3) SHS/O &A level [ ] (4) Tech/Voc. [ ] (5) Training Coll/Poly/Univ. [ ] No Educ [ ]
2.3 Number of years of schooling by household head	
2.4 Highest level of education completed by the spouse of the household head.	(1) Primary school [ ] (2) JHS/MSLC [ ] (3) SHS [ ] (4) Tech/Voc. [ ] (5) Training College/Poly/Univ. [ ]
2.5 Number of years of schooling by the spouse of the household head.	
2.5 Number of people in the household who are in school (e.g children and other relatives).	(1) Primary school …… (2 JHS…… (3) SHS ……

	(4).Tech/Voc…….5.TrainingCollege/ Polytechnic/University……..
2.6 Number of people who are learning other trade (e.g. hair-dressing, carpentry).	

1. Agricultural Knowledge Gained and Institutional/Policy factors to Market Access

Were you trained/have access to any forum to gain knowledge (market access) as a result of	***Crop variety***	***Household head***		***Spouse***		***Any other member of the household***	
		Yes = Y No = N	***# of times***	***Yes [ ] No [ ]***	***# of times***	***Yes [ ] No [ ]***	***# of times***
3.1 Agricultural extension services	Maize						
	Rice						
	Soya						
3.2 Farmer seminar/workshop/conference attendance	Maize						
	Rice						
	Soya						
3.3 Farmer field school	Maize						
	Rice						
	Soya						
3.4 Crop demonstration farms	Maize						
	Rice						
	Soya						
3.6 Farmer-based-organization							
3.7 Any other agricultural related training received							
3.8 Any other capacity building training received (financial management, other skills).							
Institutional Variables							
3.9 Membership of any socio-economic group							

(e.g credit union, community susu, etc)							
3.10 Access to market information							
3.11 Access to storage facilities							
3.11 Are you part of ACDEP intervention programmes							
3.12 If no do you belong to any other intervention programme							
3.13 If Yes to above (3.12), name the intervention prog.							
3.13Do you have contract with ACDEP/FBO/NRGP							

4.0a FARM INPUT AND OUTPUT IN 2015

Main crop of Farmer: Rice [ ] Maize [ ] soybean [ ]

Crop Type	***ICV Yes [ ] No [ ]***	***Farm size (acres) (ICV)***	***Farm size (acres) (Own seed)***	***Total farm size (acres)***	***Output (bags)***	***Output Value (GH¢)***	***Mono C Yes [ ] No [ ]***	***Mixed C Yes [ ] No [ ]***
Rice								
Maize								
Soybean								
Groundnut								
Millet								
Sorghum								
Others								

ICV=Improved Crop Variety

4b

Crop	*Chemical fertilizer*		*Organic fertilizer*		*Weed Control (Herbicides)*		*Weed control (manual)*	
	Qty	*Cost/unit*	*Qty*	*Cost/unit*	*Qty*	*Cost/unit*	*Yes [ ]*	*No [ ]*
Rice								
Maize								
Soybean								
Groundnut								
Millet								
Sorghum								
Others								

4c Kindly fill the table below with respect to the practices introduced by ACDEP or if you practiced it

Strategy	**Yes**	**No**	**Perception impact on your business/ output**				
			High	**Medium**	**Low**	**No impact**	**Negative**
Do you use improved/certified seeds for planting?							
Do you conduct germination test?							
Do you plant in rows with recommended spacing?							
Do you apply fertilizer to your crop							
Do you weigh your produce before selling?							
Do you sort your produce before selling?							
Do you label the bag for identification purposes?							
Do you collectively market your produce as a group?							
Do you have access to market information e.g. prices, quality, road condition?							
Are these market information relevant to you?							

If not introduced by ACDEP, who introduced the strategies to you…….
……
……

Part 2: CROP PRODUCTION, UTILIZATION AND FOOD SECURITY

Crop	Form Codes B	Stock before 2015 harvest (bags)	Production(Total harvest in kg) during 2015	Total Available stock after 2015 harvest = 3+4
1	**2**	**3**	**4**	**5 =3+4**
Rice				
Maize				
Soybean				
Codes B 1. Fresh/green 2. Dry				

Part 2. Contd.

From the total available stock after 2015 harvest season (column 5)						Ending stock (Stock before 2016 harvest) (kg)	If total available stock of 2015 was not sufficient for consumption until 2016 harvest	
Quantity sold after 2015 harvest (bags)		In kind payments (labour, land etc.) paid during 2016 cropping year (kg)	Seed use during 2016 cropping year(kg)	Gift, tithe, donations during 2016 cropping year (kg)	Consumption during 2016 cropping year (kg)		Amount bought (kg)	Food Aid/gifts received (kg)
6		**7**	**8**	**9**	**10**	**11**	**12**	**13**
Crop	Season							
	M L							
Rice								
Maize								
Soya								
M = Main season L = Lean season								

Part 2: CROP PRODUCTION, UTILIZATION AND FOOD SECURITY

Crop	Form Codes B	Stock before 2015 harvest (bags)	Production(Total harvest in kg) during 2015	Total Available stock after 2015 harvest = 3+4
1	**2**	**3**	**4**	**5 =3+4**
Rice				
Maize				
Soybean				
Codes B 1. Fresh/green 2. Dry				

Part 2. Contd.

From the total available stock after 2015 harvest season (column 5)						Ending stock (Stock before 2016 harvest) (kg)	If total available stock of 2015 was not sufficient for consumption until 2016 harvest	
Quantity sold after 2015 harvest (bags)		In kind payments (labour, land etc.) paid during 2016 cropping year (kg)	Seed use during 2016 cropping year(kg)	Gift, tithe, donations during 2016 cropping year (kg)	Consumption during 2016 cropping year (kg)		Amount bought (kg)	Food Aid/gifts received (kg)
6		**7**	**8**	**9**	**10**	**11**	**12**	**13**
Crop	Season							
	M L							
Rice								
Maize								
Soya								
M = Main season L = Lean season								

Part 3: MARKETING OF CROPS

One row per sale (different months, different buyers), per crop and per season

Crop (from column 1 of Part 2)	Form (from column 2 of Part 2	Market type **Codes A**	Quantity Sold kg (refer from column 6 of Part 2)		Who sold **Codes B**	Price Ghc/kg		Month sold **Codes C**		Period to payment after selling, weeks (if immediate write zero)	Buyer **Codes D**
1	**2** **1=Fresh/green 2=Dry**	**3**	**4**		**5**	**6**		**7**		**8**	**9**
			Main season	**Lean season**		**Main Season**	**Lean season**	**Main Season**	**Lean season**		
Rice											
Maize											
Soybean											

Codes A	**Codes B**	**Codes C**	**Codes D**
1. Farmgate 2. Village market 3. Main/district market	1.Spouse 2. Husband 3. Others e.g. chn	1.January 7. July 2.February 8. August 3.March 9. September 4.April 10. October 5.May 11. November 6.June 12. December	1.Farmer group/ Coop 2. Rural Assembler/ Nucleus Farmer 3. Consumer or other farmer 4. District Aggregator 5. Regional Aggregator/Company e.g. SFMC 6. Processor 7. Exporter Others, specify……..

Contd. Part 3

Relation to Buyer **Codes E**	Quality **Codes F**	Sales tax/charges (Ghc)	Time taken to sell crop (minutes)- time for negotiation	Time taken to get to the market (minutes)	Mode of transport **Codes G**	Actual transport cost (Ghc)
10	**11**	**12**	**13**	**14**	**15**	**16**

Codes E: 0. No relation but not a long time buyer

1. No relation but a long time buyer
2. Relative 3. Friend 4. Money lender.

Others, specify…….

Codes F

1. Below average
2. Fair and average
3. Above average

Codes G : 1. Bicycle 2. Tricycle 3. Donkey cart 4. Back/head load 5. Hired truck

6. Public transport

Others, specify…….

Part 3b TRANSFER AND OTHER SOURCES OF INCOME DURING 2015 CROPPING YEAR

(If several household members earn the same income source, fill according to the earning family member in separate rows)

Sources	Who earned/received 0=None; 1=Women 2=Men; 3=Both	Unit (e.g. month, week, day)	No. of units worked /received	Amount per unit (Cash & in –kind)		Total income (Cash & in -kind)		Total income (Ghc)
				Cash (Ghc)	Payment in kind **cash equivalen**t	Cash (Ghc)	Payment in kind **cash equivalen**t	
1	**2**	**3**	**4**	**5**	**6**	**7 =4*5**	**8=4*6**	**9=7+8**
1. Rented/sharecropped out land								
2. Rented out donkey for ploughing								
3. Salaried employment								
4. Farm labour wages								
5. Non-farm labour wages								
6. Other business NET income (shops, trade, tailor, sales of beverages etc)								
8. Pension income								
11. Remittances (sent from non-resident family and relatives living elsewhere)								
13. Sales of firewood, making, charcoal etc.,								
15. Sale of crop residues (e.g legumes, rice, soya, etc)								
20. Galamsey /Gold mining								
22.Rental property (other than land)								

Part 4. Labour Structure - Hired

Farming Activities	*No. of labourers Hired*		*Number days hired*		*Wage per day per person*		*Other Cost of input application*	
	Male	*Female*	*male*	*Female*	*Male*	*Female*	*Fuel*	*T & T*
4.1 Land clearing/spraying								
4.2 Ploughing								
4.3 Harrowing								
4.4 Planting/sowing								
4.5Weedicide/herbicide application								
4.6 Weeding								
4.7 Fertilizer Application								
4.8 Harvesting								
4.9 Aggregation of produce								
4.10 Bagging								
4.11 Loading								
4.12 Transportation of produce								
4.13 Threshing								
4.14 Winnowing								

Note: T & T denotes the transportation cost of labourers from the community to the farm.

5 Labour Structure - Family

Farming Activities	*Number family labourers*				*Number of days worked*			
	Adults (18 years & above)		*Children (Below 18 years)*		*Adults (18 yrs. & above)*		*Children (Below 18 years)*	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
5.1 Land clearing/spraying								
5.2 Ploughing								
5.3 Harrowing								
5.4 Planting/sowing								
5.5 Weedicide/herbicide application								
5.6 Weeding								
5.7 Fertilizer Application								
5.8 Harvesting								
5.9 Aggregation of produce								
5.10 Bagging								
5.11 Loading								
5.12 Transportation of produce								
5.13 Threshing								
5.14 Winnowing								

Part 6 ACCESS TO FINANCIAL CAPITAL, INFORMATION AND INSTITUTIONS

Household credit needs and sources during 2015 cropping year

Reason for loan	Needed Credit **Codes A**	If yes in Column two, did you get it. **Code A**	Sources of Credit **Codes B**	If not in column 3 then why not? **Code C**	Did you get the amount you requested? **Codes A**	How much did you get (Ghc)		Annual interest rate charged(%)	Duration of repayment **Code D**		Was the duration adequate Code A	Debt outstanding including interest rate at end of year
1	2	3	4	5	6	7		8	9		10	11
						In cash	**In kind**	**In cash**	**In kind**			
Land preparation												
Buying seeds												
Buying herbicides												
Buying fertilizer												
Buying farm equipment												
Investment in transport												
Non- farm business												
Consumption needs, (health,/education, tax/travel etc.												
Codes A 1 =Yes	**Codes B** 1. Money lender 2. Farmer group/Coop			**Codes C** 1. Borrowing is risky 2. Interest rate is high					**Codes D** 1. 6 months			

2= No	**3.** Susu **4.** Microfinance **5.** Bank **6.** Relative **7.** Others, specify……..	3. Too much paper work/beaureucracy 4. Expected to be rejected hence did not apply 5. I have no asset for collateral 6. No money lenders in this area for this purpose 7. Lenders don't provide the amount needed 8. No Financial/credit Assoc. available 9. Others, specify……...	2. 1 year 3. 1.5 years 4. 2 years	

SECTION E: OFF-FARM ACTIVITIES, ACCESS TO SOCIAL AMENITIES AND INSTITUTIONAL FACILITIES

7.0 Off-farm Activities

Off-farm activities comprise the following (Tick appropriately) ***[1]Salary/wage employment (e.g. nurse, teacher, doctor, agric officer, driver etc) [2] Self-employed (e.g. carpenter, mason, painter, auto mechanic etc.) [3]Petty trading/Retailing (e.g. kiosk or store operator, buying and selling at road side etc.)***											
HH	***Hours/day***		***Days/week***		***Weeks/month***		***Farm income (GH¢)***		***Off-Farm income***	***Remittances (Abroad and Home)***	***Off-farm income***
	Farm	***Off-farm***	***Farm***	***Off-farm***	***Farm***	***Off-farm***	***Other crops***	***Live-stock***	***Non-farm business***		***Wages***
HHH											
Spouse											
1.											
2.											

Note: Write the number of hours worked per day (e.g 8hrs/day), number of days per week (e.g; 3 days/wk), week per month (2 wks/month) and income earned for the year (GH¢500 from livestock last year).

8. Access to Social and Institutional Amenities

Basic social amenity/facility	**[1] Yes [2] No**	**Distance (km)**	**Distance in time (e.g. 1hour, 15 mins.)**
8.1 School (at least primary school)			
8.2 Health centers			
8.3 Portable water			
8.4 National electricity grid			
8.8 Market place			
8.9 Agricultural extension office			
8.10 Good road to the farm			

Rank the following according to what buyers look for in your produce in order of importance with one (1) being the most important and five (5) least important

Attribute	Rank
Cleanliness	
Variety	
Grain size	
Grain colour	
Moisture content	
Packaging	

Which of this market information is/are available to you?

a) Market price b) Availability of maize c) Road condition d) Transport charges e) Quality of produce (more than one answer is allowed)

Rank constraints faced by actors in the table below in order of importance with one (1) being the most pressing and twelve (8) least. **Gender M [ ]** F [ ]

S/N	Challenge	Rank
1	High cost of tractor services/labour	
2	High cost of inputs	
3	Inadequate credit	
4	Inadequate extension and research services	
5	Inadequate storage facilities	
6	Poor road network	
7	Lack of trust and contractual agreements	
8	Low price of produce	
	Others (specify)……..	

Household Assets

Assets	Number	Original Purchase Price	If you were to sell one of the [ ], how will it cost	Total value
1	**2**	**3**	**4**	**5 =2*4**
Donkey cart				
Hoe				
Knapsack sprayer				
Radio, cassette or CD player				
Bicycle				
Motor bike				
Car				
Trucks e.g. pick up				
Tractor				
TV				
Cell phone				
Cutlass				

FOOD SECURITY, WELFARE INFORMATION, HOUSEHOLD CONSUMPTION AND NON - FOOD ITEMS EXPENDITURE AS A MEASURE OF WELFARE

D1. During the past 7 days, on how many days did your household consume _____?		
		Days
1	Maize, (maize porridge, nsima, ugali)	
2	Other cereal (rice, sorghum, millet, bread, pasta etc)	
3	Roots and tubers (cassava, Irish potatoes, sweet potatoes)	
4	Sugar or sugar products	
5	Beans and peas	
6	Groundnuts or cashew nuts	
7	Vegetables (including relish and leaves)	
8	Fruits	
9	Beef, goat or other red meat and pork	
10	Poultry and eggs	
11	Fish	
12	Oils/fats/butter	
13	Milk/yoghurt/other dairy	

D2.	Commodity	About how much of this commodity did your household need for consumption during the **[season]**?			During the **[season]** for how many months did you largely have to depend on market purchases or sources other than your own farm produce for your household consumption of the following staple commodities? **(If "0", go to next row)**	What was the main reason you had to buy this commodity for **[number of months]** months?
		Quantity	Units			
		0 = do not consume	**See codes below**	Weight of "other" units (kg)		
	Name				**Months**	**See codes below**
	A	**B**	**C**	**D**	**E**	**F**
1	Rice					
2	Maize					
3	Soybean					
4	Groundnut					
5	Millet					
6	sorghum					
7.	Others					

C: Weight unit codes

1 = kilogrammes
2 = 100 kg bags
3 = 90 kg bags
4 = 50 kg bags
5 = metric tonnes
6 = quintals
7 = Other

F: Reasons for buying commodities codes

1.= Did not produce enough
2 = Did not produce enough and sold some
3 = Produced enough but sold some because of good price
4 = Produced enough but sold because of lack of storage/high post-harvest loss
5 = Produced enough but sold because needed cash
6 = Produced enough but had high post-harvest losses

Household Expenditure

G1.		About how much did your household spend on _____ for domestic consumption **during the last 30 days**? **(If "Don't know", go to next item)** **0 = None** **8888 = Don't know**			
1	Maize	.....	9	Milk and dairy products	.....
2	Beans	.....	10	Sugar/Salt	.....
3	Bread	.....	11	Milling	.....
4	Rice	.....	12	Alcohol & Tobacco	.....
5	Fruits & vegetables	.....	13	Household items (soap, batteries, etc.)	.....
6	Fish/Meat/Eggs/poultry	.....	14	Transport and fuel	.....
7	Oil, fat, butter	.....	15	Cooking & lighting fuel (wood, paraffin, etc.)	.....
8	Water	.....	16	Soda/drinks (including tea)	.....

G2.	What is the current monthly rent for your home? (Enter "0" if household does not pay rent) (If household does not pay rent monthly then calculate monthly rent)	.....

G3.		About how much did your household spend on _____ **during the last 12 months**? **(If "Don't know", go to next item)**
		0 = None **8888 = Don't know**
1	Medical expenses, health care	.....
2	Education (books, school fees, uniform, etc.)	.....
3	Clothing, shoes (excluding those required for school)	.....
4	Equipment and tools (including for agriculture)	.....
5	Construction, house repair	.....
6	Debt repayment	.....
7	Celebrations, social events (funerals, weddings, etc)	.....
8	Remittances/gifts	.....