PRODUCTION, PRODUCTIVITY AND MARKET PARTICIPATION OF SMALLHOLDER COWPEA PRODUCERS IN THE NORTHERN REGION OF GHANA

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN AGRICULTURAL ECONOMICS

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DECLARATION

I, EBENEZER KONDO, author of this thesis do hereby declare that the work presented in this thesis titled **"PRODUCTION, PRODUCTIVITY AND MARKET PARTICIPATION OF SMALLHOLDER COWPEA PRODUCERS IN THE NORTHERN REGION OF GHANA",** was done entirely by me in the Department of Agricultural Economics and Agribusiness, University of Ghana, Legon except where references of other people's work was duly acknowledged. This work has never been presented in part or in whole for any degree in this University or elsewhere.

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DEDICATION

This thesis is dedicated to my dear wife, Elsie Eleanora Amaki Odonkor and daughter Eliane Horlali Kondo, who have been inspirational and source of encouragement to me throughout the course of my studies.

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ABSTRACT

This thesis analysed the production, productivity and market participation of smallholder cowpea producers in the Northern Region of Ghana. It estimated the factors influencing cowpea production participation, productivity and market participation decisions. A multi-stage random sampling was employed in selecting four major cowpea producing districts and communities. Purposive and random sampling techniques were employed to select a sample of 300 respondents comprising of 240 cowpea producers and 60 non-producers from three communities in each district. A semi-structured questionnaire guided the interviews. The Triple Hurdle Model (THM) functionally comprising of first hurdle Probit, second hurdle Probit and third hurdle Truncated normal regressions, was used to estimate the factors that influence cowpea production participation and market participation decisions. The Instrumental Variable (IV) regression model was employed to estimate the effect of intensity of market participation on productivity while controlling for endogeneity. The results revealed that the major determinants of cowpea production and market participation decisions, which are similar include gender, education, distance to nearest market, own means of transportation, access to market information, proximity good road network, labour, tractor services, value of livestock owned, access to improved cowpea seed, and extension services. Determinants of cowpea land productivity are the proportion of harvest sold, educational level of farmer, farm size, value of livestock, use of improved seed, access to credit and selling price of cowpea. Two key recommendations emerge for local government: provision of market spaces and good road infrastructure in order to reduce transaction costs and maintaining the free compulsory basic education policy. For research institutions and the private sector, development of more improved cowpea seed; investing in tractor hiring services and sale of improved cowpea seed, will boost cowpea productivity and market participation in the Northern Region of Ghana.

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LIST OF ACRONYMS

AATF	African Agricultural Technology Foundation
ACET	African Centre for Economic Transformation
AGRA	Alliance for Green Revolution Africa
CAADP	Comprehensive Africa Agriculture Development Programme
CERSGIS	Centre for Remote Sensing and Geographic Information Services
CMP	Cowpea Market Participation
CPP	Cowpea Production Participation
CRI	Crop Research Institute
CSIR	Council for Scientific and Industrial Research
DHM	Double Hurdle Model
ESRM	Endogenous Switching Regression Model
FAO	Food and Agriculture Organisation
FASDEP	Food and Agriculture Sector Development Policy
FIML	Full Information Maximum Likelihood Estimation
GCAP	Ghana Commercial Agriculture Project
GLSS	Ghana Living Standards Survey
GSGDA	Ghana Shared Growth and Development Agenda
GSS	Ghana Statistical Service
GSSP	Ghana Strategy Support Programme
ICT	Information Communication Technology
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
IMR	Inverse Mills Ratio
IV	Instrumental Variable
METASIP	Medium Term Agriculture Sector Investment Plan
MoFA	Ministry of Food and Agriculture
NGOs	Non-Governmental Organsations

OLS	Ordinary Least Squares
PFJ	Planting for Food and Jobs
PSIA	Poverty and Social Impact Analysis
SARI	Savannah Agricultural Research Institute
SPSS	Statistical Package for Software System
SRID	Statistics, Research and Information Directorate
SSA	Sub-Saharan Africa
TC	Transaction Cost
THM	Triple Hurdle Model
2SLS	Two Stage Least Squares
UN	United Nations
VIF	Variance Inflation Factor
WACCI	West African Centre for Crop Improvement

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Agricultural transformation worldwide has mostly become a significant component and the easiest path to industrialisation and economic transformation (ACET, 2017; AGRA, 2016; Timmer, 2007, 1988). This agricultural transformation process is often characterised by better economic activities with the resultant commercialisation by farmers (AGRA, 2016). Sub-Saharan African nations such as Ghana, Nigeria, Malawi and Rwanda have all experienced accelerated agricultural growth (Minde *et al*. 2008; Otsuka, 2016; Riddell & Westlake, 2006; Takeshima, 2010). Many African countries are therefore beginning to look at agriculture through a transformational perspective, hence prioritising the sector in their economic planning. A United Nations report indicates that Sub-Saharan Africa's (SSA) estimated population was 12.3 percent of the global figure in 2015, and is anticipated to represent 21.7 percent in 2050 and further 34.0 percent in 2100 (UN, 2016).

However such fast population growth, particularly in rural communities is expected to adversely impact agricultural transformation on the African continent in diverse ways. This increased growth in population will also put mounting stress on African food systems to feed its burgeoning population. Secondly, values of land and land markets development, especially in areas of favourable market access is anticipated to rise, as land is sought for purposes other than agriculture particularly for housing and other non-agricultural uses. Thirdly, as land resource becomes more inhabited, land inheritance by young people for agricultural purposes becomes practically difficult resulting in out-migration, demographic and labour market shifts that are already prevalent in relatively densely populated areas in Africa (AGRA, 2016).

The transition of smallholder agriculture from subsistence to market-orientation has gained prominence in the fields of development and agricultural economics over the last couple of years (Hu & Rahman, 2015; Kem, 2017). The global understanding of this conversion from subsistence-based agriculture to market-oriented agricultural production is of paramount significance. This emanates from the fact that it enhances the livelihoods of agriculture dependent households in developing countries (Wickramasinghe & Weinberger, 2013). Subsistence-based agriculture is characterised by low productivity and food self-sufficiency and market-oriented agricultural production is characterised by high productivity marketing surplus.

The contemporary Ghanaian agricultural policy space is anchored on four broad thematic pillars. Firstly, improved seed production and promotion aimed at promoting domestic food production, achieving food and nutrition security and improved income for farmers to curb growing expenditure on food imports. Secondly, increased fertiliser usage to ensure high productivity in the agricultural sector for sustainable job creation and increased food security. Thirdly, the promotion and strengthening of market linkages to develop a well-structured market for agricultural produce to improve income of smallholder farmers. Lastly, improved extension services to deliver effective and efficient extension services to smallholder farmers to facilitate food crop production (MoFA, 2017).

Successive governments have thus over the years, with the support of multiple NGOs, launched various projects that stimulate agribusiness agendas and link farmers to markets ((Akpalu *et al*. 2015; Abdulai & Huffman, 2000; MoFA, 2011). Total factor productivity and annual growth in agricultural value addition in Ghana from 2005-2012, was estimated to be around 3.56% and 1.44% respectively with reported poverty trends also declining gradually (AGRA, 2016; World

Bank, 2015). Therefore, in order to sustain and bolster these marginal gains achieved in the agricultural sector, the country developed the Food and Agricultural Sector Development Programme (FASDEP II) as a policy framework to engender more accelerated economic growth. This policy framework envisions the agricultural sector to spur economic growth led by the private sector that ensures increased productivity, and employment opportunities to reduce poverty (Abu, *et al*. 2016; MoFA, 2007).

Ghana's agriculture is smallholder dominated, with these farmers dwelling predominantly in rural communities, and close to 90% of their land holdings are less than 2 hectares in size and they are also resource poor (MoFA, 2011). Both regional and local agricultural policy frameworks and agricultural strategies such as Comprehensive African Agricultural Development Programme (CAADP), Food and Agriculture Sector Development Policy (FASDEP) and the Medium Term Agriculture Sector Investment Plan (METASIP) have been accented to and developed by the government of Ghana. The major objective of these policies are geared towards increased productivity and smooth participation in the market by smallholder farmers to ensure food security.

The current flagship programme of government as far as agriculture is concerned is the "Planting for Food and Jobs (PFJ)" programme. The programme aims at targeting interventions that dovetail into a transformative goal of increasing the market orientation of the smallholder farming sector. The programme is therefore designed to provide farmers with marketing support and inputs, including high yielding seed varieties and targeting better transportation infrastructure in crop growing areas.

Market participation as defined by Barrett (2008), indicates how farm households undertake the production of goods and services for auto consumption or specialise in producing those goods in

which they have a comparative advantage in producing. These farmers consume some and sell the excess for other goods and services that they desire but possess no such comparative advantage in producing. The implication, therefore, is that participation in the market place is connected with increased levels of productivity and food security (Asfaw *et al*. 2011; Barrett, 2008; World Bank, 2007).

In general, arguments for why participation in the market by smallholder farmers is essential to improving household productivity and wellbeing of rural dwellers have been compartmentalised into two (Barrett, 2008). The first is that, it gives farmers the leverage to concentrate on producing goods in which they are experienced in producing, and trading the generated surplus for other desirable goods and services for which they possesses no such comparative advantage. The other argument is that, it enables them capture greater economies of scale and technology adoption which, collectively, leads to a more rapid total factor productivity growth (Asfaw *et al*. 2012; Barrett, 2008). Improving access to markets for smallholder farm households is a potential pathway to enhancing their productivity levels.

Several studies conducted by authors such as Al-Hassan *et al.* (2006), Demeke & Haji (2014), Jari & Fraser (2009), Omiti *et al.* (2009), Siziba *et al.* (2011) and Zamasiya *et al*. (2014) reported higher earnings and chances of reducing extreme hunger, sustainable livelihoods, creation of the necessary demand and gaining of better prices. Market participation again contributes to expanded production, increased diversification in farming activities as well as adoption of modern productivity enhancing technologies.

Contextualising the situation for the Northern Region of Ghana, the region has been identified as one of the poorly endowed regions and the per capita income of the people fall far below the

national average (Marchetta, 2011). IFAD-IFPRI (2011) and Yirzagla *et al.* (2016) identify factors such as land holding size, fewer marketed crops and location for the variation in market participation rates and crop production in Ghana. They further argued that production and market participation in some selected commodities such as cowpea by smallholder farmers tends to be lowest in Northern Region of Ghana. The Northern Region is an agrarian region. However, it does not have adequate market infrastructure, when compared to Greater Accra and Ashanti Regions. Participation in food crop production is the dominant agricultural activity in the region accounting for 70%-85% of agricultural output.

Cowpea production according to Langyintuo *et al.* (2003) and MoFA (2010), is the second most important food legume crop grown in the region after groundnut, providing food security for many households. Consumption of cowpea is higher than production in Ghana as evidenced in the importation of the grain to augment local consumption (Franke & de Wolf, 2011; Langyintuo *et al*. 2003). The total area under cultivation in Ghana currently stands at 163,000 hectares with the Northern Region in particular leading the pack with about 46% of the total area under cultivation in the country (MoFA-SRID, 2016). The region has total rural households of 212, 048 representing 90% of households involved in agriculture and smallholder farming, placing second to the Upper East Region which has 93% of rural households involved in agriculture (MoFA-SRID, 2016). According to GSS (2014), an estimated number of 362,333 households harvested the crop with 44% of these households selling the produce, thereby obtaining an annual harvest and sales values of GHS105, 004.08 and GHS43,213.59 respectively of cowpea. Most parts of Ghana's rural households participating in an integrated agricultural markets are hampered by high transaction cost and other external factors. This is a disincentive for commercialisation and technology adoption by smallholder farmers.

1.2 Problem Statement

For economic growth in Africa, particularly in Ghana and other Africa countries, to be inclusive and sustainable, there is the need to develop and increase the involvement of smallholder farmers in the wider economy. Smallholder farming is undoubtedly the largest contributor to household food security and nutrition needs of majority of the populace of these countries (Senbet, 2017).

The challenge therefore of feeding this population is not new, but recent agricultural innovations and practices have underscored the fact of low productivity. Thus, productive agricultural practices of smallholder farmers are cardinal in improving food and nutrition security needs and poverty reduction in Ghana. However, these smallholder farmers are faced with markets that are imperfect and high costs of transaction that considerably reduce their incentives for market participation. This supply side constraint detract from their productivity and by extension their market participation activities (Senbet, 2017). The challenge of market participation also arises as a result of poor and inadequate infrastructure. The high transaction costs coupled with location, as well as farmer specific attributes are also contributory factors to this low productivity and market participation.

For many smallholder rural farming communities in Ghana and mostly in the Northern Region, smallholder farmers lack the resources to help them overcome the cost outlays of entering the market, such as assets and market information access (Novignon *et al*. 2017; Uchezuba *et al*. 2009). Barrett (2008) further posited that accumulation of private assets, availability of publicly provided infrastructure and services are the preconditions to enable smallholder farmers transform from being subsistence producers to higher marketable surplus producers. In this regard, agricultural commercialisation in Africa, particularly in Ghana, necessitates the need for

smallholder farmers to improve, in order for them to produce enough marketable surplus and participate in markets. Recent Ghana government policies such as the Ghana Shared Growth and Development Agenda (GSGDA) and Food and Agriculture Sector Development Policy (FASDEP II) lay emphasis on the integration of smallholder farmers to markets. However, deplorable roads and poor transport systems have remained a key market access constraint (Hollinger & Staaz, 2015). Thus, increasing market participation, rural incomes and food security will require smallholder cowpea farmers to understand the factors that influence cowpea production, productivity and market participation.

Cowpea is an important food crop produced and consumed by most households in the Northern Region. It is the second most important legume crop in terms of production capacity or volume and area under cultivation after groundnut, but with higher domestic consumption levels than groundnut. MoFA-SRID (2016) and Yirzagla *et al.* (2016), report that average farm-level productivity on farm area basis is minimal, ranging between 0.6 Mt/ha to 1.25 Mt/ha representing an achieved yield of 50%. These figures reveal that there is the potential for yield to increase to between 1.2 Mt/ha to 2.5 Mt/ha if the appropriate production and market participation conditions are available and accessible to these smallholder producers.

Mean annual production growth rates have also witnessed a declining fortune in recent years. From 2004-2009, the estimated mean annual production growth rate averaged over the six-year period was 3.62%. This six-year growth rate figure however saw a sharp decline from the 2010-2015 production period to -3.77% (MoFA-SRID, 2016). With these low production volume and yield, smallholder farmers are therefore unable to obtain high marketable surpluses to enable them participate in the market, take advantage of economies of scale and increase land productivity.

Cowpea is a food security crop in Ghana with many farmers surviving on its production as a business. Sales from their cowpea harvests enable farmers not to only buy supplemental cereal grains such as rice (for domestic consumption), for which they may not have a comparative advantage in producing in their localities, but also fertiliser and other inputs. This contributes to safeguarding their food security through cowpea production. Household consumption and marketing (selling) of cowpea harvest are reported at 46% and 40% respectively making it one of the most widely consumed and traded legumes in the Northern Region (Franke & de Wolf, 2011; IFPRI, 2013).

However, smallholder cowpea producers in the Northern Region of Ghana have not been able to out-scale production and intensified their participation in the market of the commodity which has a global market share of approximately $1.13-2.81 billion (AATF, 2012) to improve their livelihoods. This state of affairs has arisen as a result of poor logistical infrastructure rendering the transportation of agricultural produce difficult leading to increased transaction cost in the marketing process of cowpea. The resultant effect is that smallholder farmers' ability to commercialise and intensify production have been constrained culminating in low productivity and low incomes by farmers (Abdulai & Huffman, 2000; Akpalu *et al*. 2015; Langyintuo *et al*. 2003; World Bank, 2011). That increased market participation decision influences the productivity level of smallholder farmers in Ghana have not been fully and exhaustively studied and explored. It is against this backdrop of the uncertain relationship between the production, productivity and market participation of smallholder cowpea farmers that this study seeks to provide responses to the following research questions:

1. What factors affect smallholder farmers' decision to produce cowpea?
2. What factors influence the decision of cowpea farmers to participate in the market?
3. What factors influence the intensity of participation in the cowpea market by smallholder farmers in the Northern Region?
4. To what extent does the intensity of participation affect the productivity of smallholder cowpea farmers?

Based on the research questions above, the following broad hypotheses are investigated:

Hypothesis 1: Transaction cost variables influence cowpea production and market participation decisions of smallholder producers.

Hypothesis 2: Intensity of market participation, measured as proportion of the volume of cowpea output sold has a positive relationship with cowpea productivity.

1.3 Objectives of the Study

The major objective of the study is to analyse the production, productivity and market participation of smallholder cowpea producers in the Northern Region of Ghana. The specific objectives are to:

1. Identify and analyse the factors affecting smallholder farmers' decision to produce cowpea.
2. Identify and analyse the factors influencing cowpea farmers' decision to participate in the market.
3. Identify and analyse the factors that influence the intensity of participation in the cowpea market by smallholder producers in the Northern Region.
4. Determine the effect of intensity of participation on productivity of smallholder cowpea producers.

1.4 Justification of the Study

Market participation is a precursor to production and the ease of market participation opportunities also justify smallholder farmers' investment in agricultural production and productivity enhancing technologies. This serves as a push factor in propelling smallholders to continue to increase investments in more productive assets, inputs and farming practices. The absence of this constrain smallholder farmer's participation in the market due to price variation, and higher mark-up by agents with monopsony market power (De Janvry *et al.* 1991). Subsequently, smallholder farmers, are bound to be involved in subsistence agriculture and thus incapable to benefit from market reforms. Subsistence production is often characterised by limited specialisation and elementary technology, leading to low productivity and lower income. This situation has entrapped smallholder cowpea farmers, relegating them to the lower levels of production, productivity and market participation across Ghana and especially among those in the Northern Region of Ghana

(Akpalu *et al*. 2015). Higher production, productivity and market participation among smallholder cowpea producers in the Northern Region of Ghana which accounts for nearly 50% of the national production capacity of cowpea can only thrive in the face of lower agricultural related transaction costs. These transaction costs such as searching, screening, and enforcement give rise to a substantially higher smallholder production as well as participating in the agricultural commodity markets (Tadesse & Shively, 2013). Obtaining reduced transaction costs are also responsible for the proper integration of geographic markets, and perfect competition within these markets (Barrett, 2008; Gabre-Madhin, 2001).

Public investment in physical and institutional infrastructures are expected to resolve the problem of high transaction costs and also stimulate smallholder farmers to participate in the market, thereby raising net returns to agricultural production (Barrett, 2008; Renkow *et al.* 2004). Providing smallholder farmers with guaranteed markets for their farm output would, most likely reduce distress sales and thus, improve revenue from sales for smallholder cowpea producers in the Northern Region of Ghana. It has therefore been noted that having access to assured markets for farm output is considered one of the most effective mechanisms for reducing poverty in developing countries (Akpalu *et al*. 2017; 2015; Gelo *et al*. 2017; IFAD, 2010; 2003).

Barrett *et al.* (2009) and Lentz & Upton (2015) indicated that market participation is associated with marketable surplus generation. The implication is that investment in technologies that promote production and availability of productive assets will induce smallholder cowpea farmers to participate in cowpea crop production. This will then engender increased productivity among them and cause them to participate in the market. Additionally, prevailing market conditions can also influence incentives to increase gross value of output produced and therefore in integrated

markets, the returns to higher volumes of production increase than they do in markets that are isolated. Following from this, good infrastructure and strong institutions lower the cost of transaction and that considerably improve agricultural production, productivity and market participation decisions.

Lubungu *et al*. (2013), also identified proper market integration and its intensity by smallholder farmers to be related to higher agricultural productivity, greater specialisation and higher agricultural incomes. Smallholder market participation potentially contributes to food security leading to poverty reduction as well as enabling better use of resources (IFAD, 2011; Timmer, 2005), contributes to commercialised production and vigorous change in production technology (Romer, 1994). Therefore, achieving this proper integration could in turn facilitate structural change in the Ghanaian agricultural landscape, thereby offering rural farmers the prospect to transit from subsistence based agriculture into more specialised, market-oriented production systems (Chenery *et al*. 1986; Kuznets, 1973; Lewis, 1954). Mazumdar (1987) also singled out agricultural commercialisation as the way of motivating smallholder farmers to move into productive agriculture rather than migrating out of the sector.

An efficient linkage of smallholder agricultural farmers to local and national agricultural markets is a massive strategy towards achieving the agricultural related goals in the sustainable development goals (UN, 2015; Wickramasinghe, 2015). The relevance of this paradigm shift is that participation in the market by smallholders contributes towards agricultural growth, thereby inducing structural transformation in an agricultural sector-led economy. The effect of this much-needed structural transformation is the promotion of pro-poor growth and reducing the phenomenon of food insecurity among agrarian households (Wickramasinghe, 2015). Olwande *et*

al. (2015) also indicated that an obvious mechanisms that will improve smallholder farmers' living conditions in less developed countries is to integrate them into markets so they can be efficient in production and increase productivity.

In the World Development Report of 2008, it was contended that enhancing market participation improves the productivity level of smallholder farmers, and that, it is the conduit to promoting pro-poor growth in developing countries (World Bank, 2007). In this regard, introducing modern agricultural innovations and technologies to smallholder cowpea farmers coupled with the provision of various forms of governmental support from the relevant authorities will positively impact on agricultural production systems in the Northern Region of Ghana. Though a gradual shift is emerging in the structure of agricultural production system being transformed from subsistence based to commercial agriculture in Ghana (Chapoto *et al*. 2013; MoFA-SRID, 2016), this shift is very slow and involves only a negligible proportion of the Ghanaian smallholder farmer population. The Ghanaian smallholder cowpea producer over the years do not only participate in the production process but also participate in the market by selling some proportion of their produce. Thus, the provision of production, productivity and market participating enhancing services, facilities and infrastructures will accelerate the spate of agricultural commercialisation and transformation in Ghana to ensure an inclusive economic growth.

The Ghana Commercial Agriculture Project (GCAP) and the national development plan both underscore the need to graduate from a smallholder subsistence-based production system to one that is characterised by a stronger market-based orientation (Abu, *et al*. 2016). Following from that, the phase two of the Ghana Strategy Support Program (GSSP) seeks to proffer solution for achieving this overarching goal of agricultural transformation for the country. As a result, one of

the key strategic policy research areas is markets and competitiveness. In line with the vision of supporting farmers through the attainment of improved and reliable income through the planting for food and jobs initiative, improving markets for smallholder farmers is integral to ensuring higher land productivity. Akpalu *et al*. (2017) also emphasise the need for market participation resulting from higher land productivity and the vice versa driving the agricultural transformation agenda. This according to them has the ability to raise the incomes of subsistence, low input, low productivity farming systems practised by farmers in the Northern Region in particular and Ghana as a whole. To this end, boosting agricultural productivity and improving market participation of smallholder cowpea producers is considered the most promising strategy to achieving pro-poor growth, rural development and agricultural transformation in the Northern Region of Ghana.

1.5 Organisation of the Study

The study is organised into five chapters. Chapter One as described above details the introduction of the topic area. It also includes problem statement with research questions and general hypotheses, research objectives, justification of the study as well as organisation of the study. Chapter Two presents a synthesised review of relevant literature as pertains to the topic. It encompasses extensive review of empirical studies on cowpea production, productivity and market participation of smallholder farmers. Chapter Three highlights the methodology employed in the study. It includes the theoretical, conceptual and analytical frameworks, methods of data analyses, the study area and methods of data collection. Results and discussion are presented in chapter four. Finally, the summary of key findings, conclusions, recommendations and suggestions for further research form the concluding chapter of the this thesis.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on theoretical and empirical studies pertaining to participation in the market and agricultural productivity of smallholder producers. It begins by assessing the economic value of cowpea production and the determinants of the probability of cowpea production. The key terms and concepts such as smallholder farming, agricultural productivity and market participation are defined. The precise appreciation of these terms is important in understanding the analyses of cowpea production, productivity and market participation in the study area. The chapter also reviews literature on the measurement and determinants of agricultural productivity and market participation decisions. Finally, relevant literature on econometric models that have been employed in empirical studies involving market participation and productivity are also presented.

2.2 Cowpea Production

This section presents the status of cowpea production in Ghana, as well as factors influencing smallholder farmers' decision to produce cowpea.

2.2.1 Economic importance of cowpea production

Cowpea (*Vigna unguiculata* (L) Walp), is a grain legume crop. Its production constitutes an important source of food, household income and as feed for livestock. Cowpea production is a key component of tropical farming systems because of its ability to improve marginal lands through nitrogen fixation and as cover crop (Danso, 2016). Langyintuo *et al*. (2013) also reported that cowpea production is also a dependable asset that serves as income source for many smallholder

farmers and traders in sub-Saharan Africa. The grain is also a good protein source for humans, while the haulm is an important source of livestock protein (Danso, 2016; Fatokun, 2002). Cowpea is widely cultivated in Ghana under rain fed conditions, predominantly in the savanna and transition zones (CRI, 2006; Danso, 2016) and about 91% of the cowpea produced in Ghana is cultivated largely in the three savannah agro ecological zones of the country. Annual cowpea production in Ghana is estimated at approximately 203,000 Metric tons (MoFA-SRID, 2016).

It is estimated that total cowpea grain produced in the world annually is valued at approximately 1.13billion to 2.81billion United States dollars (AATF, 2012). This therefore indicates that raising the gross value of output produced per hectare or yield per hectare of the crop will consequently increase the annual global production and revenue. The foregoing also indicates the economic importance of cowpea to smallholder producers and hence factors that induce the production of the commodity must be carefully analysed to boost production. Table 2.1 below details the major cowpea producing regions in Ghana and their average production capacity for 2013-2015. These regions together account for approximately 97% of the overall cowpea production in Ghana. Figure 2.1 also shows the production index for the country from 2006-2015. Year 2016 to 2013 were calculated using average of 1996-97 as base year. Year 2014 and 2015 were calculated using average of 2006 to 2010 as base year.

Table 2.1: Top Five Cowpea Producing Regions in Ghana Averaged for 2013-2015

Region	Average Production Capacity in (Mt)	Share of Sub-Total (%)	Share of Overall Total (%)
Northern	96,398.43	49.38	47.82
Upper West	73,951.80	37.88	36.69
Upper East	12,224.61	6.26	6.06
Brong Ahafo	7,681.87	3.93	3.81
Ashanti	4,978.32	2.55	2.47
Sub-Total	195,235.02		
National Production Capacity	201,574.57		96.85

Source: MoFA-SRID, 2016.

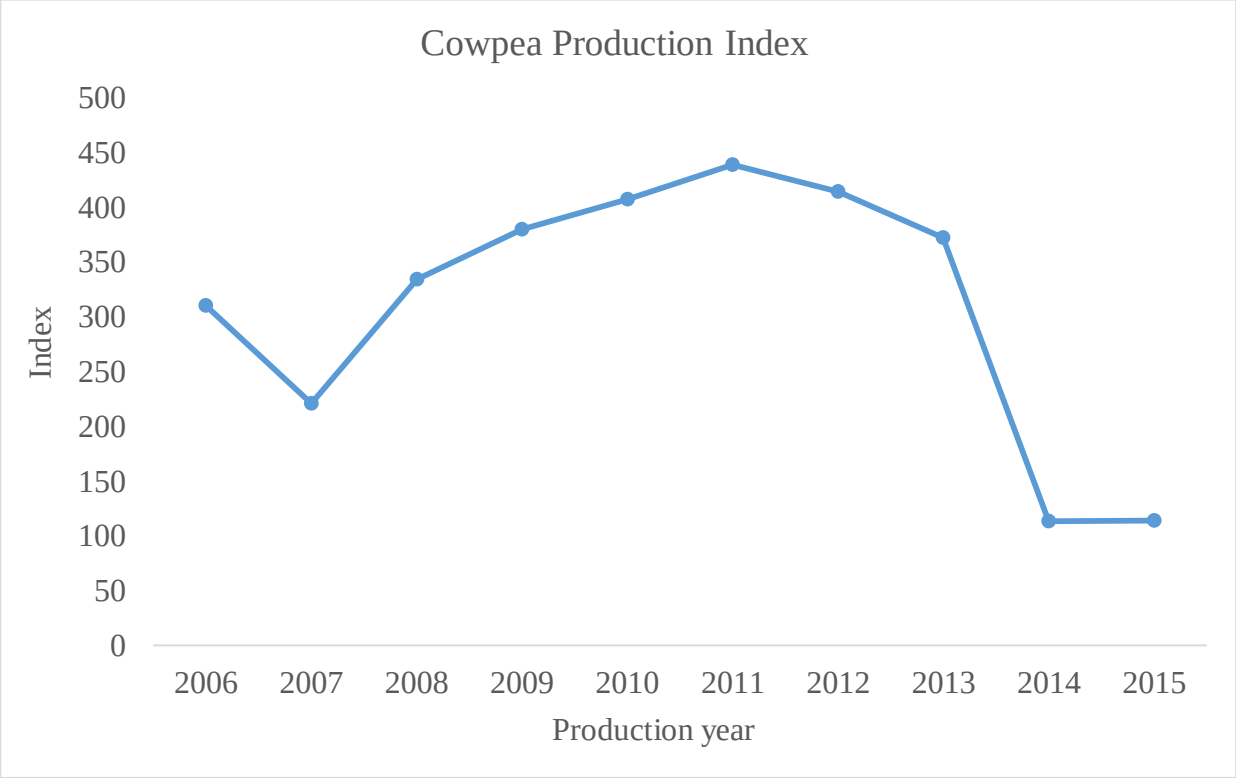

Figure 2.1: Cowpea Production Index of Ghana from 2006-2015
Source: MoFA-SRID, 2016.

2.2.2 Determinants of cowpea production

Cowpea production refers to the volume of the commodity produced by smallholder farmers based on the comparative advantage they have in deciding to be producers of the crop. A number of factors have been identified in diverse empirical studies that encourage the probability of cowpea production such that with the implementation of the right policies, non-producers can be induced to also start producing. These include access to improved and high yielding seed varieties, distance to market, proximity to an all-weather good road network, access to tractor services and farm size. Other factors such as credit access, access to extension services, livestock owned, availability of labour, smallholder farmer's level of education, fertiliser and pesticide usage, as well as gender have all been identified (Adipala *et al.*, 2000; Lifeyo, 2017; Rios *et al*. 2009; Tabe-Ojong & Mausch, 2017). Tabe-Ojong & Mausch (2017) for instance established that the relationship that exists between farm size, livestock owned, and gender and chickpea adoption and market participation in Ethiopia is significant and positive. Their findings proved that a negative relationship exist between input use and age on chickpea production. Lifeyo (2017) reported a negative relationship between proximity to good road network and common bean production in Malawi. He further reported that the relationship that exists between distance to nearest market and common production in Malawi is also negative.

2.3 The Concept of Smallholder Farming

The concept of smallholding does not lend itself to an exact definition. Vermeulen & Cotula (2010) indicated that, the definition of smallholders differs from country to country and between agro-ecological zones. In their categorisation of smallholder farmers, they aggregated those who cultivate less than 1 hectare of land in dense population regions or localities, or cultivate 10 hectares and above in semi-arid areas as smallholders as also reported in (Abu *et al*. 2015).

According to Musah *et al*. (2014) and Ekboir *et al.* (2002), a smallholder in any region of Ghana is working on a farm size that is less than 5 hectares. Chamberlin (2007) and IFPRI, (2007) also noted that 70% of Ghanaian smallholder farmers have farm size of 3 hectares (ha) or smaller in sizes. They further stated that the smallest mean land holdings are in the south, and it is about 2.3 ha at the coastal belts, but higher, that is, 4.0 ha in the northern savanna agro ecological zones. The implication of possessing smaller farms is that production volumes of commodities produced become less. For example, farm sizes of 2 ha or smaller produce on average 3.1 different types of crops whereas those of 4 ha or larger produce 4.7 different types of crops. Chamberlin's concept of smallholding is premised on farm size, wealth, market orientation and production risk susceptibility levels.

According to Ministry of Food and Agriculture (MoFA, 2011), smallholder farmers have less than 2 hectares farm size. The main argument is that smallholder farmers cultivate small plots of land. In line with this, Dixon *et al.* (2004) view smallholder farmers as possessing limited assets base compared to other farmers in the sector. Smallholder farmers are particularly vulnerable to climatic and economic shocks. Furthermore, the Ghana Poverty and Social Impact Analysis (PSIA) undertaken by Asuming-Brempong *et al.* (2004), their recommendation asserted that defining smallholder farmers in Ghana must be based on different resource and risk conditions. They contended that this is a better definition than just simply measuring landholdings. It is apparent from the literatures above that the definition of smallholder farmers was premised on the size of landholding. This might be due to the fact that, defining smallholders based on landholding was the safest and less contentious way of describing them in empirical studies. Consequently, based on the lessons from the literature, this study primarily defined a smallholder farmer based on farm

size or landholding. Therefore, the definition by the Ministry of Food and Agriculture (MoFA) of a farm size or landholding of about 2 hectares as smallholding was used for this study.

2.4 Agricultural Productivity

This section explores the diverse definitions of the concept of agricultural productivity in empirical studies. It also presents how the concept of agricultural productivity is measured in some empirical studies.

2.4.1 Definitions and concepts of agricultural productivity

The term agricultural productivity has evoked different meanings and interpretations. The term has also stimulated many contradictory interpretations with several scholars defining it with reference to their disciplines and fields of practise. In the fields of agricultural geography and agricultural economics, productivity in agriculture is therefore defined as output per unit input or produce per unit of land size. Singh & Dhillion (2000) proposed yield per unit as the important consideration in the definition of agricultural productivity. However, this definition has been criticised by several authors saying it only considered land as a production factor. Following from that, several authors have proposed an all-encompassing concept of agricultural productivity. The productivity concept should constitute all the production factors such as labour, capital, water management and other biotic factors (Dharmasiri, 2009).

Productivity in agriculture from the perspective of Shafi (1984), is the ratio of index of local farm produce to the total farm input use index. Productivity therefore represents, *ceteris paribus*, the effectiveness with which inputs are utilised in the production process. The concept sometimes too is considered as the total efficiency with which a production system functions, while at other times it is defined as a ratio of produce to resource collectively or separately expended on that

production. According to Dewett & Singh (1966), the term agricultural productivity must be expressed in terms of the changing association between agricultural output and one other input, such as land or labour or capital, with other corresponding factors remaining the constant. Their definition indicates that agricultural productivity is rather a physical component instead of it being a broad concept. In the view of Pandit (1965), the term agricultural productivity must be defined from an economic perspective. He indicated that agricultural productivity is expressed as the produce per unit of input or the art of achieving an increase in output from the same input or getting the same output from a smaller input. Pandit again suggested that rises in agricultural productivity, whether in the industrial or agricultural sectors, is usually borne out of an effective use of all or some of the factors of production, namely; land, labour and capital. Saxon (1965), also perceived productivity in agriculture as a visible relationship existing between produce and input which results in that produce.

Horring (1964) studied agricultural productivity in expansive terms, to represent the ratio of produce to some or all associated inputs. He further corroborated the views espoused by Dharmasiri, (2009) that there are varying concepts of productivity which are dissimilar from each other. Land, labour and capital are the various aspects of agricultural productivity. Due to increasing human population, exceptional consideration has been given to land productivity than the other forms of productivity. The reason is that land is perceived is a resource with different natural attributes. Land receives diverse payments and this cost payments or rent vary proportionally with regard to need and location. Labour productivity on the other hand denotes all the services performed by humans, which does not involve decision making, while capital represents resources employed in cultivation by the farmers that are non-labour related. Production optimality from land is achieved with the application of relevant and accessible inputs.

Predictably, the inherent physical and chemical properties of land vary based on location with the resultant variation on agricultural land use. Following from this, productivity of land is of outmost importance in countries and locations with high agrarian populations such as the Northern Region of Ghana. Horring (1964) further stated that in countries with scarce land resources, production and productivity increases can only keep pace with economic growth per capita if yield per hectare is raised. However, raising land productivity requires raising the national farm output rather than just raising the yield of individual crops. Land productivity can also be raised by varying crop production patterns to incline towards an intensive system of cultivation higher value crop like cowpea to achieve higher productivity. The focus of the study therefore is on the productivity of land.

2.4.2 Measurement of agricultural productivity

Several scholars have endeavoured quantifying agricultural productivity. The coefficient of ranking method was introduced by Kendall as the procedure for agricultural productivity measurement in 1939. The measurement of agricultural productivity usually involves a relationship between inputs and outputs in agricultural production. Stamp (1958) used Kendall's approach for comparing agricultural productivity across countries. He further emphasised the measurement of crop productivity in terms of per unit area. Measuring relative productivity in terms of gross output of crops and livestock has also been reported in other empirical studies. For instance, Hirsch (1943) proposed crop yield index as the basis of productivity measurement. His measurement approach expressed the average of the yields of different crops on a farm or in a locality relative to the yields of the same crops on another farm in another locality.

For their part Huntington and Valkenburg (l952) considered land productivity on the basis of acre yields of eight crops grown very extensively in Europe. Makenzie (1962) on the other hand measured productivity of production in Canadian agriculture by using the output coefficient relative to input. For Sapre & Deshpande (1964), the weighted rank index is a more appropriate measurement of productivity in the agriculture sector. The agricultural productivity coefficient index computed based calorie levels of each crop was also introduced as agricultural productivity measurement by (Shafi, 1984). Agricultural productivity has also been measured by expressing it in terms of per unit area carrying capacity (Singh, 1972). Hussain, (1976), also developed the method of converting farm production into cash values of a regional unit in production as a productivity measure. Commen (l962) while working out the trends of productivity in agriculture of the state of Kerala (India), measured productivity on the basis of yield per acre.

Other empirical studies by authors such as Strasberg *et al.* (1999) and Govereh & Jayne (1999) in their studies of Kenyan and Zimbabwean farmers respectively, measured agricultural productivity as the overall value of crop production per acre. For example, Rios *et al.* (2009) computed a technical efficiency score as a measure of agricultural productivity. They argued that measurement of productivity via technical efficiency considers both output and input levels. Agricultural productivity is also the gross value of output produced per hectare according to (Gilligan, 1998; Gebremedhin *et al*. 2017; Minten & Barrett 2008; Tabe-Ojong & Mausch, 2017).

2.5 Market Participation

This section defines the concept of market participation and examines its measurement. It also identifies market participation determinants and as well as determinants of crop productivity. The section also discusses the factors influencing smallholder farm household's decision to participate

in the markets and how intensity of market participation affect the productivity of smallholder cowpea farmers.

2.5.1 Concepts and definitions of market participation

Numerous definitions and operationalisation of the concept of market participation have emerged in several empirical studies following the pioneering work of Goetz (1992). He indicated that households typically are confronted with a dichotomous or two-stage decision problem. The first decision is related to which direction to trade if a farmer decides to trade. The second decision involves the quantity or volume of good to be traded based on participation as a purchaser or a seller. Also, according to Latt & Nieuwoudt (1988) and Strasberg *et al.* (1999), market participation can be termed as commercialisation giving rise to agricultural transformation. Increased market participation or commercialisation implies the shift from subsistence farming to market participation mode. Boosting participation in markets is necessary to sustain the linkage of farmer to markets in order to increase purchase of agricultural produce to trigger income generating opportunities (Pingali, 1997). From the point of view of Pingali, market participation is not merely the marketing agricultural produce. He argued that agricultural market participation is achieved when profit maximisation is the ultimate motive driving household's product choice and input use decisions.

In an agricultural market economy, participation in the market happens when smallholder farmers stop being mostly subsistence or peasant and become more profit-oriented (Makhura *et al.* 2001). According to Ana *et al.* (2008) market participation can be defined as sales portion of total produce aggregated for all agricultural crop produced by a smallholder household. This crop production according to him includes a combination of all annuals and perennials crops, industrial and crops

locally-produced, fruits and agro-forestry. Supporting Pingali's assertions, Dawit *et al.* (2006) posit that market participation involves three pillars. These include; input against produce, sales against purchases, and the type of farming activity dichotomies. Meanwhile Moti *et al.* (2009) insist that market participation considers input and output sides of production, and how farm households simultaneously make production and marketing decisions.

Barrett (2008) indicated that the concept of market participation involves how smallholder farmers undertake the production of goods and services for auto-consumption. He continued by saying that the concept also involves how smallholder farmers specialise in the production of goods in which they are skilled in producing, consuming some portion and selling the surplus for other goods they are not skilled in producing. Hazell *et al*. (2007) found out that agricultural market participation in terms of the intensity of participation in the output markets focuses primarily on cash incomes.

The following studies also all defined market participation as any market venture which promotes the sale of produce (Holloway & Ehui, 2002; Key *et al*. 2000; Lapar *et al*. 2003). According to Boughton *et al.* (2007), participation in the market is both a cause and an effect of economic development. This he explained by indicating that market participation offers households the chance to specialise according to comparative advantage and hence enjoy welfare gains through trading. Market participation plays a substantial role in raising productivity and thereby enhancing farm earnings of smallholder farmers (Asfaw *et al*. 2012; Barrett *et al*. 2012; Bellemare, 2012; Chege, *et al*. 2015; Hernandez *et al*. 2007; Maertens, *et al*. 2012; Michelson, 2013; Muriithi & Matz, 2015; Rao & Qaim, 2011; Rao, *et al*. 2012). All these authors defined market participation as the proportion of sales by smallholder farmers conditional on the famer being a seller. Increased participation in the market implies the shift from subsistence farming to a market engagement

mode. This frequent use of markets is undertaken for the purpose of exchanging products and services (Mmbando, *et al.* 2015; Musah *et al*. 2014). Smallholder producer's choice to participate in agricultural markets is considered an essential determinants of household agricultural productivity, level of commercialisation and kind of crop diversification practised on-farm (Asfaw *et al*. 2012; Lipper *et al*. 2010; Lipper *et al*. 2006; Smale, 2006).

2.5.2 Measurement of market participation and intensity of participation

Goetz (1992) used the quantity or volume of produce traded as a measure of the intensity of market participation. Ana *et al.* (2008), employed sales index as a measure of market participation. Rios *et al.* (2009) also measured market participation using sales as a fraction of total output, aggregated for all agricultural crop produced by a smallholder household and computed a sales index, measured as equal to zero (=0) for a non-seller and greater than zero (> 0) for a seller. Their study was the first of its kind to link intensity of market participation to productivity and established a reverse causality between the two concepts whiles controlling for endogeneity. However, their operationalisation of the concept of market participation truncates vital information since the decision to produce the crops studied and the decision to sell them were not modeled in their estimations.

They explained that households that sell nothing would have a zero sales index and index for those who sell would be greater than unity. Following from Barrett (2008), two fundamental measurement approaches can be deduced. He asserts that smallholder households partake in the market principally either as sellers or buyers. Both decisions according to him are underpinned by the optimisation theory where households seek to maximise utility subject to cash budget and availability of non-tradable resources. Again from the point of view Barrett, partaking in the

market possess a demand side where households participate as buyers, and a supply side where they act as sellers. Cazuffi & Mckay, (2012) and Makhura *et al*. (2001) also computed an index as a proxy for market participation. However, their use of commercialisation index as an alternative measure for market involvement has been perceived to possess some deficiencies and therefore not an efficient indicator (Moti *et al*. 2009).

Burke *et al.* (2015) and Lifeyo (2017), viewed market participation as a three-stage phenomenon. The first stage involves a production decision and conditional on a farmer being a producer, the second stage involves the market participation decision where the farmer then decides to be a net buyer, remain autarkic or be a net seller. They further indicated that the third and final stage is the decisions regarding volumes or proportion of their net purchases and net sales which determines their degree or intensity of market participation. However, although Gebremedhin *et al*. (2017) and Tabe-Ojong & Mausch (2017) also operationalised market participation as a three-stage process, their measurement of the concept did not involve the second stage net buyer, autarkic or net seller specifications as used in Burke *et al.* (2015). Their market participation measurement involved the decision to participate in production as the first stage, decision to market or sell as the second stage. However, conditional on being a participant in the market as a seller, the proportion or volume of output sold defines the third stage which also measures the intensity of participation.

2.5.3 Determinants of market participation and crop productivity

Agricultural production in developing countries often occur in a constrained environment characterised by low production volume, low productivity as well as prohibitive transaction costs which slow down market participation (Novignon *et al*. 2017). These emanate from the insufficient availability and access to public goods such as physical infrastructure namely roads, electricity, and telecommunication networks and institutional infrastructure (Barrett, 2008; Francesconi & Heerink, 2010; Gabre-Madhin, 2001; Gelo, *et al*. 2017). Evidence shows that the factors that affect market participation and productivity are in broad categorisations and these include household (farmer) characteristics, transaction costs and community characteristics. Other factors such as resource endowments/institutional factors comprising of private assets, public assets/social capital, location and market prices variables are also noted that affect market participation and productivity. Cazzuffi & McKay (2012); Stifel *et al*. (2003), Masuku *et al.* (2001) and Wickramasinghe, (2015) have all indicated that most studies have mainly dwelled on understanding the role of costs associated with transaction and market failure in smallholder decision making by taking into consideration their proximity or distality from a market source. Other authors such as Key *et al.* (2000); Barrett (2008); Bellemare & Barrett (2006) also concluded from their studies that differential resource or assets endowments facilitate participation in the market. They therefore identified them as important factors underlying market participation decision making as well as crop productivity increases among smallholders.

With regards to transaction costs variables affecting participation in the market place, Goetz (1992) noted that such costs affect participation in the market through the labour-leisure trade-off behaviour. He expounded that in markets that are not well developed, it is expensive to identify opportunities for selling or trading. This poor market access can be explained in terms of

inadequate transportation system, long distance to markets, ethnicity or language barriers raising the cost of observing prices in the market in order to make purchase decisions. This therefore reduces the household's leisure time as a result of the spending of more time in search for market prices. Additionally, Cazzuffi & Mckay (2012), discovered a positive association existing between partaking in the market and lower levels of transaction costs especially transport information costs (Alene *et al.* 2008; Heltberg & Tarp, 2002; Ouma *et al.* 2010). However, contradictions emerged from among some of these various specific studies. For instance, Siziba *et al.* (2011) found that three of the transaction cost variables they measured; ICT index, distance to output markets and market information (price information) positively influence market participation. They established a positive effect of ICT index which measured the number of mobile phone subscriptions per 100 people and price information. They conclusion they drew from this observation is that the provision of public infrastructure and services promote market participation and productivity.

With regards to the distance to market variable, they also interestingly observed a positive relationship between longer distance to market and market involvement. They explained that this can be possible provided better prices are offered in such markets. Studies by authors such as Randela *et al.* (2008), Siziba *et al.* (2011) and Zamasiya *et al*. (2014) also observed a positive relationship existing between distance to market and market participation, and also between accessing market information and market participation. However, Olwande & Mathenge (2012) and Omiti *et al.* (2009) found distance to market to be negatively related to market participation among milk and kales; and milk and fruit producers respectively. Similarly, Lifeyo (2017) and Martey *et al.* (2012) also found negative effect between distance to market and market participation of smallholder common bean and cassava producers respectively. The argument backing this

observation was that, market distance represents a cost in getting to markets as it is an indicator of travel time and hence a longer distance serves as a disincentive to participate in the market.

Wickramasinghe, (2015) also attempted to determine whether or not a major difference exists in maize market entry and sales. He undertook this study among smallholder farmers who operated pure-stands and those who operated mixed stands. His hypotheses were that households who operate pure stands should expect to encounter lower and less significant transaction costs than households who operate mixed-stands. He observed that for pure-stand farmers, transaction costs variables such as distance to market and cost of transportation are significant and positive rather than the expected negative sign. However for mixed-stands farming households, the same transaction costs variables households were significant and negatively related to market participation.

Wickramasinghe (2015) again observed that household resource endowment indicators such land area, the number of productive household members (dependency ratio), soil quality, access to irrigation services and farm implements significantly influenced market participation decisions. Additionally, labour access, tractor services, usage of fertilizer and pesticide, extension services are significant in regards to the proportion or volume of maize sales and therefore all indicating signs of enhanced market participation. His conclusions were that access to resources greatly determine the volume of maize produced and sold. However, in their triple hurdle model estimations, Gebremedhin *et al.* (2017) identified resource endowment variables such as labour, land and access to credit to be positively related to engagement in diary production, but population density and off-farm income source were found to be negatively related. Gebremedhin *et al.* (2017), also corroborated the findings of Burke *et al*. (2015) and identified previous investments,

access to own land and possession of assets to be positively related to production decisions among diary producers in Kenya.

Other empirical evidence also show the relationship existing between market participation and household characteristics and resource endowment variables (private assets/public assets). These variables are noted to generally exhibit positive association with market participation (Boughton *et al.* 2007; Cadot *et al.* 2006; Levinsohn & McMillan, 2007; Martey *et al.* 2012; Nyoro *et al.* 1999; Siziba *et al.* 2011; Stephens & Barrett, 2009; Zeller *et al*. 1998). Zamasiya *et al*. (2014) and Siziba *et al*. (2011) further observed that private assets indicators including non-farm income, ownership of radio and value of livestock owned were highly and positively significant with the intensity of market participation in the grains market and productivity. Socioeconomic characteristics such as age in studies by (Martey *et al*. 2012; Randela *et al*. 2008; Zeller *et al*. 1998) education for example (Martey *et al*. 2012; Olwande & Mathenge, 2012; Omiti *et al.* 2009; Zeller *et al*. 1998) and farm size for example (Martey *et al.* 2012).

With regards to gender, households headed by males participate more in the market, have higher production volumes and productivity counterparts. Omiti *et al. (*2009) also observed that the gender variable had a positive effect on market participation of various farm produce. Resource endowment variables such as ownership of private assets like mobile phone or communication instrument, own means of transportation such as bicycle, motor king etc. and membership in a farmer-based organisation (Olwande & Mathenge, 2012; Reyes *et al.* 2012), and output for example (Omiti *et al.* 2009) had a positive effect on market participation decisions. However, dependency ratio or household size has been found to negatively affect market participation and proportion of sales in studies by scholars such as (Olwande & Mathenge, 2012; Omiti *et al*. 2009;

Randela *et al*. 2008). In a stark contradiction, Randela *et al.* (2008) observed a negative effect of farm size and ownership of livestock on market participation and proportion of sales.

Cadot *et al.* (2006) and Alene *et al*. (2008) all found that, the closer a farmer is to a main market source, the greater their likelihood of market participation and generation marketable surplus as a result of higher productivity. On the other hand, lack of market information impede market participation by increasing the cost of bargaining and searching. In addition, poor road infrastructure along with inadequate road networks noticeably impedes market participation. Rainy seasons in many rural areas render roads virtually impassable thereby resulting in high costs of transportation. The effect is that the price received by farmers are further reduced if buyers are to provide transport in such situations. According to Obare *et al*. (2003), insufficient road infrastructure is connected with poor development of markets through high transaction costs. Consequently, the distal a household is away from main market source in a district, transaction costs of obtaining information and travel time in getting to such market outlets are high. Likewise, proximity to main towns and market centres indicates how short farmers have to travel to reach sources of information (Makhura *et al*. 2001). Renkow *et al.* (2004) found that fixed transactions costs, on average is relatively lower in areas with reliable motorised transport services but higher for areas without reliable motorised transport services in a study conducted on Kenyan smallholder households.

Other studies conducted in Asia also show that transaction costs have negative effect on market participation of smallholder farmers. For example, in Peru, market participation was low among smallholder potato producers because of the high transaction costs resulting in lower productivity in places where formal markets are inaccessible (Maltsoglou & Tanyeri-Abur, 2005). Lappar *et*

al. (2003), also reported the decreasing effect of transaction costs on the production and market participation of smallholder Pilipino smallholder livestock farmers. Similarly, Gebremedhin *et al*. (2017) also reported of the same effect on the production and market participation of smallholder livestock farmers in Ethiopia while Tabe-Ojong & Mausch (2017) also observed the same effect on chickpea production and market participation among smallholder farmers in Ethiopia.

In yet another extremely interesting empirical analysis Asfaw *et al*. (2012) discovered the determinants of produce and input market participation on pigeonpea diversity in Kenya. Their study used cross-sectional data and connected market participation to household welfare and food security. Their study revealed that input and produce market participation decisions and their determinants are different. They identified participation in the output market to be influenced by household's socio and demographic characteristics, farm size and ownership of radio. The input market participation was also determined by farm size, ownership of bicycle, and access to a salaried income. Their study established a strong positive correlation of produce market participation and pigeon pea diversity, while a negative relationship exists between input market participation and pigeon pea diversity. Their results indicated that smallholder farmers who participated in the produce market had significantly higher food security status than non-participants.

In examining the effect of ICT-based market information and adoption of seed technologies in Uganda, Kiiza & Pederson (2012) noted that the factors affecting the probability of access to market participation include credit or loan access and membership in a farmer based organisation. They also discovered that government awareness campaigns, wealth and distance to trading centres or district capital negatively affect access to markets and production. They discovered that

participation in improved seed production had a positive and significant effect on productivity and gross farm returns.

2.6 Methodological Issues in Market Participation and Crop Productivity

This section presents the empirical models for analysing the effect of market participation on productivity of smallholder farmers. It also presents the model for identifying the factors that influence smallholder farmers' decision to produce cowpea, factors that influence smallholder farmers' decision to participate in the markets as well as determining the effect of productivity on intensity of participation in the cowpea market.

2.6.1 Linking market participation to productivity: the two-step approach

In empirical studies of market participation in particular, several econometric models have been applied. In practice, these studies characteristically adopt a two-step methodical approach. This double-hurdle approach is appropriate or useful especially where the population being studied all produce the crop or commodity which is under investigation (Cragg, 1971; Olwande & Mathenge, 2012; Omiti *et al*. 2009).Other studies assume a one-step procedure.

The motivation for using the two-step estimation framework is that market participation is often perceived as a dual concept and processes following the pioneering work of (Goetz, 1992) and later (Bellemare & Barrett, 2006). The operationalisation of the first decision process has to do with whether a farm household would participate in the market or not. The second decision process deals with the level of output with which to participate if the farm household decides in the first stage. However, some other empirical studies by Omiti *et al*. (2009) and Martey *et al*. (2012) have considered only a one step approach by concentrating on the second decision process. The three-stage analytical approach has been advanced to handle the shortcomings of the two-tier approach

in situations where the population do not all produce the crop or commodity under investigation (Burke *et al*. 2015; Gebremedhin *et al*. 2017; Lifeyo, 2017; Tabe-Ojong & Mausch, 2017).

Gebremedhin *et al*. (2017), Alene *et al*. (2008), and Olwande & Mathenge (2012), have all stated that econometric models for the double-hurdle approach also include models such as Heckman's sample selection model for example (Goetz, 1992; Makhura, *et al*. 2001; Boughton *et al*. 2007; Alene *et al*. 2008; Siziba *et al*. 2011), the two-tier/double hurdle models (e.g. Cragg, 1971; Olwande & Mathenge, 2012; Reyes *et al*. 2012) and endogenous switching regression model (e.g. Seng, 2016). The instrumental variable (two-stage least squares) regression approach (Rios *et al*. 2009).

The Heckman Selection Model

The Heckman sample selection model was introduced by Heckman (1979). The initial model was based on wage offer functions given that some wage data was missing due to the outcome of another variable – participation in the labour force. The procedure is easy for correcting sample selection bias. Wooldridge (2002) argues that the sample selection bias can be seen as an omitted variable in the sample selected which is corrected by using the Heckman model.

The Heckman model is made up of two equations to be estimated in two steps and therefore a double hurdle. The first equation is known as the selection equation. This selection equation is estimated using either a Probit or Logit model which estimates the probability that an individual household either participates or does not participate in the market. The procedure involves the prediction of an Inverse Mills Ratio (IMR), the purpose of which is to account for sample selection in the study so that the estimates would not be biased. The second equation is known as the outcome equation. The Ordinary Least squares (OLS) approach is used in estimating this outcome

equation. The OLS estimation is done with the inclusion of the IMR as an explanatory variable. The first and the second models incorporate the same variables except that the second model includes some other variables suggested by Wooldridge (2006) as exclusion restriction variables. An obvious drawback of the Heckman's sample selection model is that, the exclusion restriction variable(s) be identified based exclusively on distributional assumptions (Sartori, 2003). He further observed that the exclusion restriction assumption is also noted sensitive to the assumption of bivariate normality (Winship & Mare, 1992). It is also observed that the rho parameter is also very sensitive in some common applications (Sartori, 2003). The model also fails to incorporate production decision in the estimation process.

Tobit – a Two-tier/Double Hurdle Model

Cragg (1971) developed the two tier/double hurdle model and it has since been the most prominent technique adopted for most empirical studies on market participation. Cragg first proposed the two-tier model as a general form of the Tobit model. The model allows for the possibility that a factor might have diverse effects on the probability of acquisition and the size of acquisition. Olwande & Mathenge (2012) view the two-tier/hurdle models as a type of corner solution outcome which is sometimes denoted as censored regression. The model's application to any empirical study splits the study into two steps/stages. The first is an initial discrete probability of participation model and conditional on participation, the second step is the decision made in regards to the intensity of participation (Olwande & Mathenge, 2012). The first initial step is modelled as a Probit analysis while the second step assumes varied functional distributions.

Though the simplest two step models assume Log normal distribution in the second stage, Cragg's double hurdle model assumes a truncated normal distribution. The merit of the truncated normal

distribution over the lognormal is that the Tobit model is nested in the truncated normal regression thereby allowing the testing of the restrictions implied by the Tobit hypothesis against the two step model (Olwande & Mathenge, 2012). This makes the double hurdle model theoretically plausible than other two-tier models however both models are incapable for analysing situations where a significant number of the sampled population are non-producers of a crop or commodity and it is required that a production decision be modelled.

The Endogenous Switching Regression Model

The endogenous switching regression model (ESRM) was first described by Maddala (1983) and has since been used in several empirical studies (Akpalu & Normanyo, 2014; Camara, 2017; Hu & Schiantarelli's 1998; Seng, 2016). This model is also a two-stage model designed to overcome the restriction of the Tobit model. The estimation procedure in the endogenous switching regression model is that a variable is able to influence the two stage decisions in different directions (Alene *et al.* 2008; Seng, 2016). The first procedure or stage as suggested by Maddala (1983) is the estimation of the selection equation, followed by the calculation of the selection correction terms and then inserting them into the second stage outcome equations. With dichotomous dependent variable, the second stage is a discrete choice model which has to be estimated using maximum likelihood methods. However, the use of the Full Information Maximum Likelihood (FIML) method to simultaneously estimate the selection and outcome equations of the endogenous switching regression (Mmbando *et al*. 2015) is reported to be efficient than the two-step least squares method (see e.g. Akpalu & Normanyo, 2014; Clougherty & Duso, 2015; Greene, 2000; Lokshin & Sajaia, 2004; Seng, 2016). The drawback with this approach is that it also fails to take into consideration the decision to produce.

The Two-Stage Least Squares (Instrumental Variable) regression

The main approach that has been used extensively in empirical studies to address endogeneity is the two-stage least squares (instrumental variable) regression approach (see e.g. Babu *et al*. 2014; Dunning, 2008; Greene, 2012; Rios *et al*. 2009; Staiger & Stock, 1997). Intensity of market participation is potentially endogenous in the cowpea food crop productivity model and therefore in order to overcome the problem of endogeneity, the Instrumental Variable (IV) approach using the Two-Stage Least Squares (2SLS) estimator was employed. The alternative estimation procedures was to employ the Ordinary Least Squares (OLS), the Heckman sample selection model or the Tobit model. But all these estimation methods are limited in addressing the issue of endogeneity that is perceived to be associated with the intensity of market participation (proportion of sales) and productivity (gross value of output sold per hectare). The estimators associated with these approaches would be biased and inconsistent. The instrumental variable approach allows for the estimation of coefficients that are consistent and free from asymptotic bias from omitted variables as well as measurement errors (Angrist & Krueger, 2001).

The foremost economist to employ the procedure was P.G. Wright. Wright (1928), who first discussed the issue in the seminal application of instrumental variables in estimating the elasticities of supply and demand for flaxseed, the source of linseed oil. Following from that, several other Economists such as Goldberger (1972), Morgan (1990) and Bowden & Turkington (1984) have all applied the instrumental variable procedure in diverse econometric analyses. According to Angrist & Krueger, (2001), if there is more than one valid instrument, the coefficient of interest can be estimated by two-stage least squares. While two-stage least squares and other instrumental variables estimators are consistent and unbiased, the drawback of the approach is that it can also result in biased and inconsistent estimates if invalid or weak instruments are used and the model

incorrectly specified leading to under or over identification issues. These estimation challenges were addressed in this study by conducting the Durbin-Wu-Hausman test statistics and the joint significance test of instruments validity. Rios *et al.* (2009), also employed the 2SLS followed by a two-tailed Tobit models to establish a link between productivity and market participation. They regressed productivity on a range of possible determinants of intensity of market participation, and a variety of control variables drawn from the productivity literature.

The control variables include household characteristics, private and public assets and services (resource endowments)/institutional factors, market prices and location. They used transaction costs variables such as household's ownership of means transportation and proximity to good road network as instrumental variables.

The validity of each of this plausible instrumental variables, depends on the extent to which it is related with a household's productivity level only through their intensity of market participation and not through any direct linkage to production. Though Rios *et al.* (2009) measured agricultural productivity in terms of technical efficiency by computing technical efficiency scores as a measure of productivity, cowpea productivity measurement for this study followed the works of Gilligan (1998), Tabe-Ojong & Mausch, (2017) and Gebremedhin *et al*. (2017). They measured agricultural productivity as the gross value of output produced per hectare.

2.6.2 The triple hurdle model of market participation

The triple hurdle market participation involved the decision to participate in production, conditional on a farmer being a producer, decision to participate in the market, and conditional on being a participant in the market, the proportion or volume of output sold. Most empirical studies on market participation have operationalised the participation of households into output markets

as a two-stage decision process and either employed a sample selection model such as the Heckman's sample selection (see e.g. Alene *et al*. 2008; Bellemare & Barrett, 2006; Boughton *et al*. 2007; Ouma *et al*. 2010). Other scholars have also employed a corner solution model notably the endogenous switching regression models, restrictive Tobit model and the double hurdle models (Camara, 2017; Goetz, 1992; Omiti *et al*. 2009).

The triple hurdle modelling approach starts modelling from production and implicitly assumes all households in the study area to be either producers or potential producers. This assumption is plausible if more than two crops are considered in the model and where all smallholder farmers are actually producers of the crops under investigation. However, in the case of cowpea, not all smallholder farmers in the study area are producers.

A significant number of smallholder farmers in the study area are non-produces even though they have the potential or capacity to produce. All households (both producing and non-producing) must be modelled such that any policy intervention which encourages producers to market may also induce non-producers to begin producing and also participate in markets (Burke *et al*. 2015). An extension of the DHM called the triple hurdle (THM) models such relationships by including an additional tier for the production decision since the double hurdle model does not allow explicitly for this possibility. Following from this, market participation studies are beginning to take the shape and form of a TH model (see e.g. Gebremedhin *et al*. 2017; Okoye *et al*. 2016; Tabe-Ojong & Mausch, 2017; Lifeyo, 2017) after the pioneering work of Burke *et al*. (2015) on production of diary and market participation in Kenya.

Motivated by a major limitation of the DH which only modeled producer households, they introduced the triple hurdle (TH) model which includes an initial stage of production to capture

non-producers. Burke *et al*. (2015) and Lifeyo (2017) operationalised their triple hurdle market participation into the following distinct categorisations based on the works of Bellemare and Barrett (2006). They modelled the production participation decision as a Probit model for the first stage decision, conditional on a smallholder being a producer, market participation was categorised as either a net buyer, autarkic or net seller and the factors connected with it were modelled using an Ordered Probit. They then analysed the last hurdle of intensity of participation (measured as net volumes bought by buyers, and net volumes sold by sellers) using two lognormal specifications based on (Wooldridge, 2010).

Furthermore, Cameron & Trivedi (2005) also proposed either the log normal specifications or Truncated regression for estimating the last hurdle in hurdle models. Following from that, other studies by Gebremedhin *et al*. (2017) and Tabe-Ojong & Mausch (2017) operationalised the first stage decision to produce using a Probit model. They operationalised the second stage market participation decision by the producer smallholder farmers into market participants and non-participants and the factors associated with it were also modelled using a Probit model. Finally, conditional on partaking in the market as a seller, the level of participation (proportion of output sold) was estimated using a Truncated regression model.

Tabe-Ojong & Mausch (2017), linked adoption of chick pea variety to market participation using the triple hurdle model approach while controlling for heterogeneity and endogeneity in factors associated with chick pea adoption that also potentially affect market participation. Though this study followed the approach of Tabe-Ojong & Mausch (2017), productivity measurement followed the approach by Govereh & Jayne (1999) and Strasberg *et al*. (1999). Therefore, for the analyses of cowpea production, market participation and the intensity of participation conditional on

smallholder producers' decision to sell and their level of productivity, in the Northern Region of Ghana, the 3- stage or TH model was employed.

2.7 Key Conclusion on Literature Review

From the literature review, several studies were identified in relation to market participation and smallholder farmers' production. Current empirical studies on market participation are gradually shifting away from the two-step analytical approaches to the three-step or triple hurdle models (see e.g. Burke *et al*. 2015; Gebremedhin *et al*. 2017; Tabe-Ojong & Mausch, 2017; Lifeyo, 2017). This 3-step approach is applicable in studying a crop like cowpea where a significant number of smallholder farmers are non-producers.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the methodology of the study under the following: the theoretical framework underpinning the study and the conceptual and analytical frameworks, the methods of data analyses and data collection, and the *a-priori* theoretical expectations underlying the identified explanatory variables. The chapter also provides a description of the study area.

3.2 Theoretical Framework

Market participation decisions usually results from the joint decision of production and consumption. Therefore, the basic non-separable agricultural household production and consumption model as developed by Singh *et al.* (1986) was employed. The key assumption underlying this model is that market failure for both factor and product markets make the production and consumption decisions of agricultural households non-separable (Sadoulet & Janvry, 1995; Singh *et al.* 1986; Tabe-Ojong & Mausch, 2017). However, households maximise their utility by choosing their level of consumption (c_i), production volume (q_i), productivity level (b_i), proportion of output available to be sold (s_i), obtained in the production process with the application of inputs (x_k) and input price (p_k) in production technology F. The household then maximises this utility subject to available income/cash constraint, input and output quantity balance, production technology, the market prices and a set of non-negativity constraints as represented in the equations below.

$$\underset{C_i,q_i,b_i,s_i,x_k}{Max} \quad U(c,z_u) \tag{3.1}$$

subject to

$$\sum_{i=1}^{N} p_i^m (s_i - b_i) - \sum_{k=1}^{M} p_k x_k + Y \geq 0 \tag{3.2}$$

$$q_i - x_k - C_i + b_i - s_i + E_i + T_i = 0 \tag{3.3}$$

$$F(q,x: z_p, z_m) \geq 0 \tag{3.4}$$

$$p_i^m \text{ is given} \tag{3.5}$$

$$C_i, q_i, b_i, s_i, x_k \geq 0 \tag{3.6}$$

$$i = 1, \ldots \quad N \text{ and } k = 1, \ldots \quad M$$

Where p_i^m is the market price of cowpea i, E_i denotes resource endowments/institutional factors, transaction costs is represented by T_i. z_u, z_p and z_m are vectors of household production characteristic, productivity measure and characteristic measuring the intensity of market participation respectively. Y represents transfers and other incomes while F represents the production technology of the household. The available farm production income and the revenue from sales and other off-farm activities must be greater than or equal to the expenditure from household purchases and inputs used in production. The input and output balance also suggest that the total quantity consumed, used as input and sold in the market cannot exceed the quantities produced, bought and the endowment of the household. The production technology constraint refers to a production function that is well-behaved and relates all physical inputs to physical output considering other production shifters.

Transaction costs (TC) have been identified to greatly impact market participation. For instance, Alene *et al*. (2008), Barrett (2008) and Burke *et al*. (2015) have used the concept of transaction cost to explain the market participation behaviour of farmers Transaction cost includes distance to

the nearest market and access to market information and ownership of means of transportation (Sadoulet & Janvry, 1995). Therefore, assuming the influence of transaction costs is stated as follows ($t_i^c(A, G, Z, Y)$) for trading in the market at a price p_i^m for each good i. Transaction costs can either be proportional transaction cost (PTC, t_i^p) or fixed transaction cost (FTC, t_i^f). These costs are jointly dependent on private asset holding, A (landownership, labour, off-farm-income, access to improved cowpea seed, total output, household income, and livestock holding), public assets and services vector G (access to tractor for ploughing, extension, proximity to good road network, credit) as well as household characteristics (e.g age, gender, dependency ratio, education, farm size etc.), represented by the vector Z.

3.3 Conceptual Framework

The conceptual framework presented in Figure 3.1 outlines the pathway that underpins smallholder farmers' market participation and productivity decision making. Smallholder farmers first and foremost decide whether or not to be producers or non-producers of a commodity. Conditional on the smallholder farmer deciding to be producers, it means they have the comparative advantage in producing the commodity based on the theory of market participation. They then decide whether or not to produce and sell in the market and be market participants or for household or auto-consumption and be non-market participants. In some cases some of the smallholder producers also participate in the market by buying from the market or from other producers. Conditional on being a market participant, the final decision the household makes is in relation to the proportion or volume of output to be sold or if they participate as buyers the proportion or volume of output to be bought. In producing for trading or marketing purposes, some of the smallholders again consume some of the produce obtained and trade or market the surplus from their production. It is expected that in trading the surplus from their production volume, they generate income. The

consumption of the income generated as a result of market participation is devoted to both agricultural and non-agricultural purposes. However, in relation to agricultural purposes, the cash or income generated enables smallholder farmers overcome production related constraints such as cash for purchase of inputs. These smallholders are therefore able to purchase and spend on farm inputs and services such as improved cowpea seed variety, fertiliser, facilitating access or hiring of tractor for ploughing. All the activities undertaken using the income generated through market participation facilitate increased cowpea productivity. It must also be stated, however, that a low income or cash from market participation due to low prices received for goods traded could prove a disincentive thereby causing a previous market participant becoming a non-market participant.

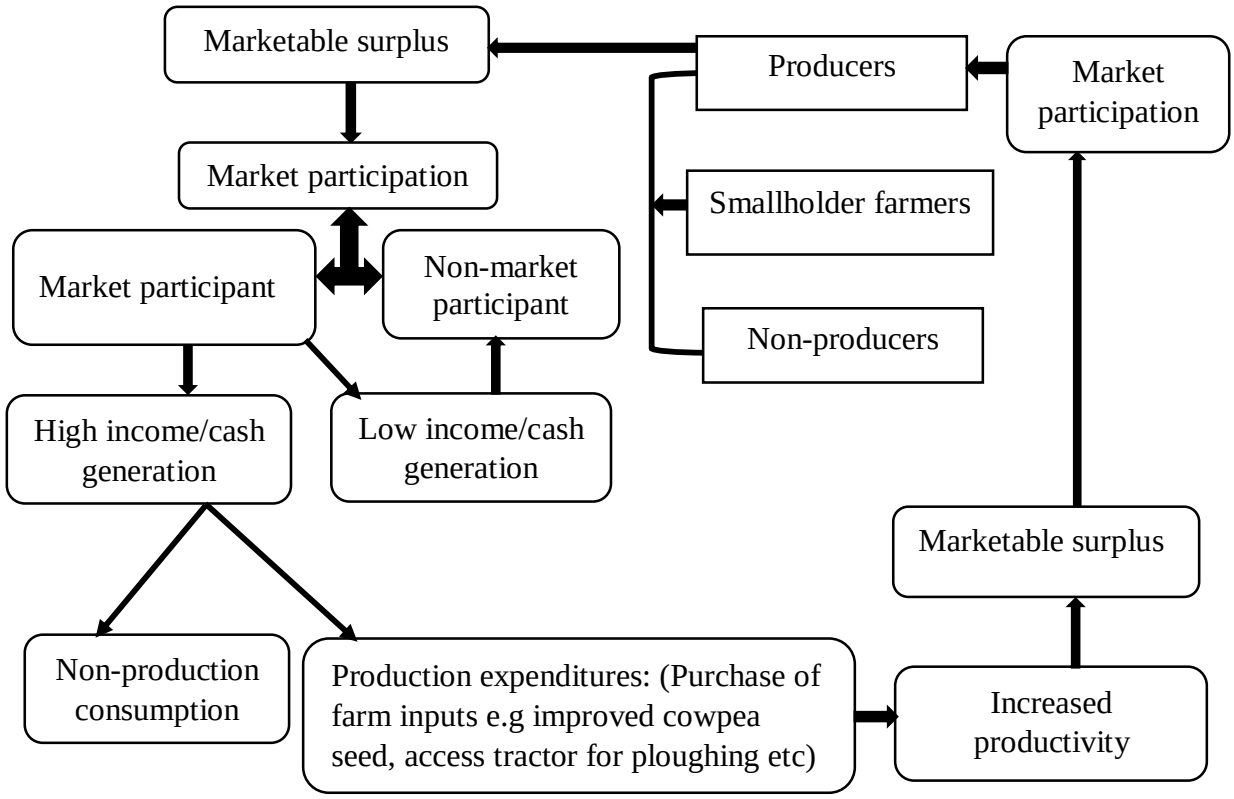

Figure 3.1: Conceptual Framework of Market Participation and Productivity
Source: Author's own conceptualisation based on literature, 2018

3.4 Analytical Framework of Market Participation and Productivity

Following from the conceptual framework in Figure 3.1, the analytical framework linked the factors that influence cowpea production, productivity and market participation decisions. Probability of cowpea production and market participation decisions was analysed simultaneously using the triple hurdle model. Smallholders decide whether to be cowpea producers or non-producers while also deciding either to be market participants or non-market participants. Conditional on being a market participant, the intensity of participation or proportion of output sold is determined. This intensity of market participation is hypothesised to affect productivity.

In Figure 3.2, the arrows from household characteristics, resource endowments (private and public assets and service variables)/institutional factors, transactions costs, location variables, and market price(s) are all hypothesised affect cowpea production, productivity and market participation decisions.

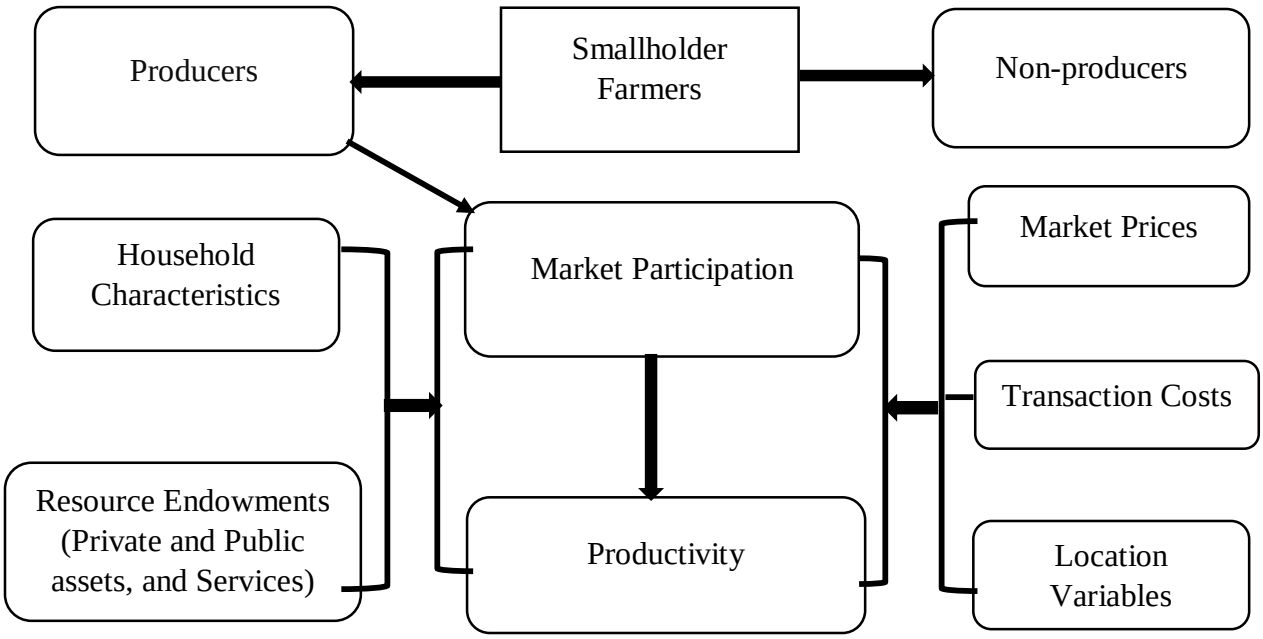

Figure 3.2: Analytical Framework of Market Participation and Productivity
Source: Author's own conceptualisation based on literature, 2018.

3.5 Methods of Data Analyses

This section presents the description of analytical methods employed in achieving the specific objectives of the study: i) Identifying the factors affecting smallholder farmers' decision to produce cowpea, ii) Identifying the factors that influence smallholder farmers' decision to participate in the cowpea markets and iv) Identifying the factors influencing the intensity of participation in the cowpea market and, iv) Determining the extent to which smallholder farmers' intensity of participation in the cowpea market affect their level of productivity.

However, the study is limited in scope. Burke *et al*. (2015) and Lifeyo (2017) theoretically classified market participants in the output markets into three distinct categories: net sellers (households with positive net sales), autarkic (households with zero net sales or households who produce purposely for household consumption) and net buyers (households with negative net sales). This study however lacked the required comprehensive data set in terms of quantity of cowpea output bought from the market by respondents to perform such an estimation.

This study operationalised market participants as farmers with an aggregate supply of cowpea to the market which is greater than zero, in other words farmers who are net sellers. Though the proportion of non-cowpea producers in the sample was relatively small, it did not significantly impact on the estimates obtained from the study since the sample size of sixty (60) which used for non-producers in the estimations was statistically sufficiently large enough (Boss & Hughes-Oliver, 2000). Additionally, the determination of which of the communities within the districts to select was also informed by physical access and therefore the sample may be biased towards households with relatively better market access.

3.5.1 Analytical approach of the triple hurdle model (THM) market participation

The triple hurdle estimation method was used to identify the factors affecting smallholder farmers' decision to produce cowpea, factors that influence smallholder farmers' decision to participate in the cowpea markets and also to determine the extent to which smallholder farmers' productivity level affect the intensity of participation in the cowpea market. The model was estimated simultaneously via the maximum likelihood estimation procedure in order to account for endogeneity bias. Following from Gebremedhin *et al.* (2017) and Tabe-Ojong & Mausch (2017), the triple hurdle model used for the study can be expressed mathematically as follows:

Probit model representing the decision to produce cowpea and their predicted probabilities:

$$CPP_i^{p*} = \alpha W_i + \nu_i$$

$$CPP_i^{p} = \begin{cases} 1 & if\ CPP_i^{p*} > 0 \\ 0 & Otherwise \end{cases} \quad (3.7)$$

Probit model representing the decision to participate in the market and their predicted probabilities:

$$CMP_i^{p*} = \beta X_i + z_i$$

$$CMP_i^{p} = \begin{cases} 1 & if\ CMP_i^{p*} > 0 \\ 0 & Otherwise \end{cases} \quad (3.8)$$

The general specifications of these probit models are derived respectively for (3.7) and (3.8) below:

$$G(W'\alpha) = \Phi(W'\,\alpha) = \int_{-\infty}^{\omega'\,\alpha} \phi(v)dv \quad (3.9)$$

$$F(X'\beta) = \Phi(X'\beta) = \int_{-\infty}^{X'\beta} \phi(z)dz \quad (3.10)$$

Where $G(W'\alpha)$ and $F(X'\beta)$ represent the conditional density functions of the standard normal distributions.

Truncated regression model of the intensity of participation in the market (proportion of sales):

$$IMP_i^* = \delta V_i + u_i$$

$$IMP_i = \begin{cases} IMP_i^* \; if \;\; IMP_i^* > 0 \;\; and \;\; IMP_i^p = 1 \\ 0 \;\; Otherwise \end{cases} \quad (3.11)$$

The general specification of the truncated regression model is also represented below:

$$\mathrm{E}(y|y > 0) = V'\delta + \sigma\lambda\left[\frac{V'\delta}{\sigma}\right] \quad (3.12)$$

Where CPP_i^{p*}, CMP_i^{p*} and IMP_i^* are the unobserved latent variables representing the probability to participate in cowpea production, market participation and the intensity of participation or proportion of volume of output sold respectively by the *i*th smallholder farmer. $\boldsymbol{W}$ and $\boldsymbol{X}$ represent vector of exogenous variables that affect the likelihood of cowpea production and the probability of selling in the market respectively, and $\boldsymbol{V}$ a vector of exogenous variables hypothesised to be associated with the intensity of market participation defined in terms of proportion of cowpea harvest sold (marketed) by smallholder farmers with α, β and δ representing their corresponding parameter estimates. Equation (3.7) signifies the probability of producing cowpea, and it is a binary choice of whether to produce cowpea or not. It assumes the value of 1 if the household produces cowpea or 0 otherwise. Equation (3.8) also signifies the probability of participation in the market, and it is a binary decision of either participating as a seller or not. It assumes the value of 1 if the smallholder participates in the market as a seller or 0 otherwise. Equation (3.11) represents the intensity of market participation which is the decision regarding the proportion of the volume of cowpea harvest sold in the market. The dependent variable is measured as the proportion of marketed quantity of production of cowpea by producers based on their level of productivity. The graphical representation of the triple-hurdle model market participation is represented in Figure 3.3.

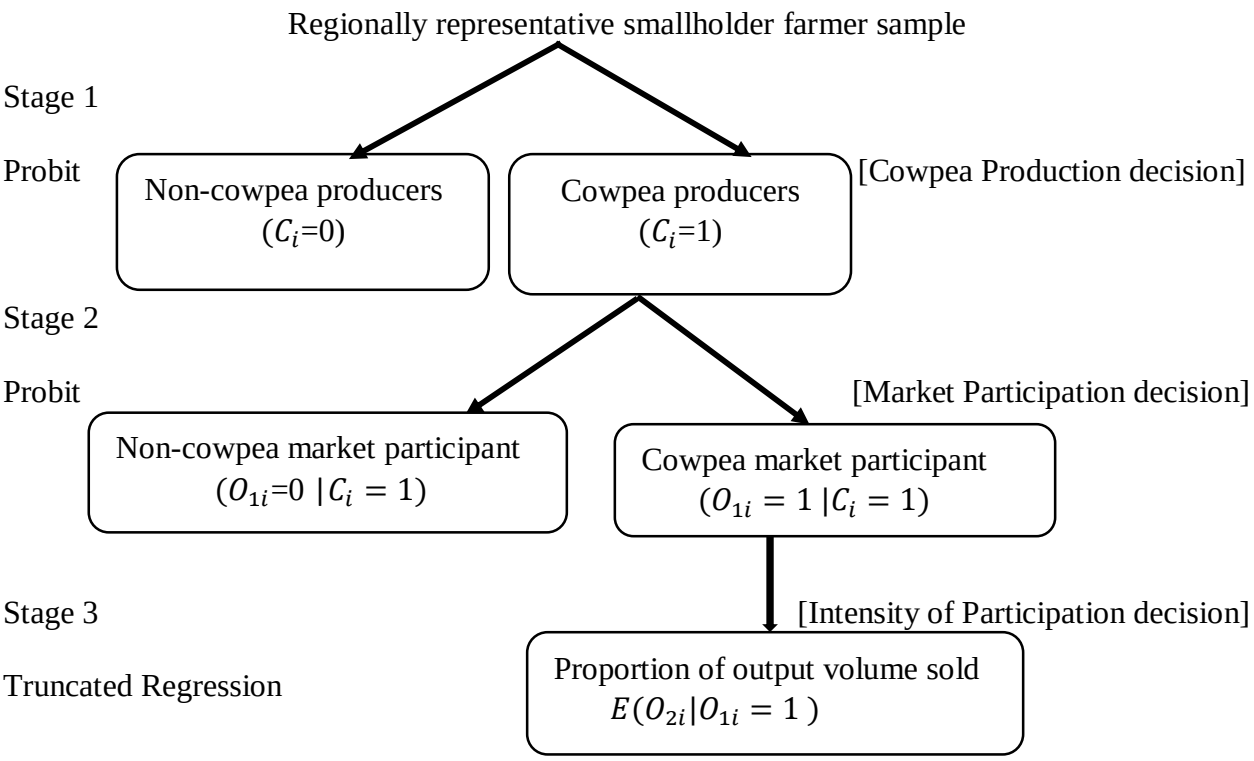

Figure 3.3: Graphical Representation of the THM Market Participation
Source: Adapted from Gebremedhin *et al*. (2017) with modifications.

3.5.3 Empirical models for the THM market participation

The triple hurdle model is specified as a function of household characteristics (hc), transaction costs (tc), resource endowments (re), market price (p) and location variables (l). The estimated models are therefore depicted as follows:

$$Cowpea\ Production\ Participation\ (CPP) = (hc, tc, re, p, l) \quad (3.13)$$

$$Cowpea\ Market\ Participation\ (CMP) = (hc, tc, re, p, l) \quad (3.14)$$

$$Intensity\ of\ Market\ Participation\ (IMP) = (hc, tc, re, p, l) \quad (3.15)$$

The empirical model specifications are stated as follows:

$$CPP = \alpha_0 + \alpha_1 Age + \alpha_2 Gender + \alpha_3 Depratio + \alpha_4 Educy + \alpha_5 Fsize + \alpha_6 Distmkt + \alpha_7 Omt + \alpha_8 Ami + \alpha_9 Grn + \alpha_{10} T\_income + \alpha_{11} Ofi + \alpha_{12} Labour + \alpha_{13} Landown + \alpha_{14} Livestock + \alpha_{15} Cowvar + \alpha_{16} Tracplough + \alpha_{17} Credit + \alpha_{18} Ext + \alpha_{19} Tolon + \alpha_{20} Yendi + \alpha_{21} Mion + \alpha_{22} Kum + v_i \quad (3.16)$$

$$CMP = \beta_0 + \beta_1 Age + \beta_2 Gender + \beta_3 Depratio + \beta_4 Educy + \beta_5 Fsize + \beta_6 Distmkt + \beta_7 Omt + \beta_8 Ami + \beta_9 Grn + \beta_{10} T\_output + \beta_{11} T\_income + \beta_{12} Ofi + \beta_{13} Landown + \beta_{14} Livestock + \beta_{15} Cowvar + \beta_{16} Tracplough + \beta_{17} Credit + \beta_{18} Tolon + \beta_{19} Yendi + \beta_{20} Mion + \beta_{21} Kum + \varepsilon_i \quad (3.17)$$

$$IMP = \delta_0 + \delta_1 Age + \delta_2 Gender + \delta_3 Depratio + \delta_4 Educy + \delta_5 Fsize + \delta_6 Omt + \delta_7 Ami + \delta_8 Grn + \delta_9 Toutput + \delta_{10} T\_income + \delta_{11} Landown + \delta_{12} Livestock + \delta_{13} Cowvar + \delta_{14} Credit + \delta_{15} C\_price + \delta_{16} Tolon + \delta_{17} Yendi + \delta_{18} Mion + \delta_{19} Kum + u_i \quad (3.18)$$

3.5.4 The instrumental variable regression model: 2SLS estimator

The instrumental variable approach using the Two-stage least squares (2SLS) estimator was used in determining the effect of intensity of market participation on productivity of smallholder cowpea producers. Following from Angrist & Krueger (2001), Goldberger (1972) and Rios *et al*. (2009), the Instrumental Variable 2SLS model for productivity can be modelled as follows:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + \alpha_2 \tilde{\theta}_i + \varepsilon_{1i}$$
$$\theta_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \nu_{1i}$$

Where Y_i is productivity measured as gross value of cowpea output produced per hectare for cowpea production for smallholder farmer i, $\alpha_0, \alpha_1, \alpha_2, \beta_0, \beta_1, \beta_2$ and are unknown parameter estimates of interest, X_i is a vector of common exogenous regressor variables hypothesised to be correlated with cowpea crop productivity, $\tilde{\theta}_i$ is the predicted values of proportion of output sold used to measure the intensity of market participation, θ_i is the intensity of market participation

itself that is potentially endogenous in the productivity model, ε_i is an error term X_{2i} is a vector of instruments for intensity of market participation and v_i is an error term. Where the $E(\varepsilon_{1i}) = 0$ and $cov(\varepsilon_{1i}, v_{1i}) = 0$.

The empirical model specification for the Instrumental Variable 2SLS estimation is stated as:

$$Loggvcp\_Hectare = \beta_0 + \beta_1 IMP + \beta_2 Age + \beta_3 Gender + \beta_4 Depratio + \beta_5 Educy + \beta_6 Fsize + \beta_7 Distmkt + \beta_8 Ami + \beta_9 LogT\_income + \beta_{10} Labour + \beta_{11} Livestock + \beta_{12} Cowvar + \beta_{13} Tracplough + \beta_{14} Credit + \beta_{15} Ext + \beta_{16} LogC\_price + \beta_{17} Tolon + \beta_{18} Yendi + \beta_{19} Mion + \beta_{20} Kum + \varepsilon_i \quad (3.19)$$

Table 3.1: Description of Dependent and Explanatory Variables used in the Analyses

Variable	Description/Measurement		Model(s)
Dependent Variables			
PRODUCTIVITY	Log of gross value of cowpea produced per hectare, GHS/ha		2SLS
CPP	Cowpea Production Participation decision/ Dummy (1=Producers, 0=Non-producers)		PBR
CMP	Cowpea Market Participation decision/Dummy (1=Market participant, 0=Non-market participant)		PBR
IMP	Intensity of Market Participation/continuous and also as an endogenous variable in the IV estimation		2SLS/TRR
Explanatory Variables		Sign	
Household Characteristics			
AGE	Age of respondent/Continuous variable	+	2SLS/THM
GENDER	Gender /Dummy (1=Male, 0=Female)	+	2SLS/THM
DEPRATIO	Ratio of inactive to active labour/continuous	+	2SLS/THM
EDUCY	Educational level of respondent in years	+	2SLS/THM
FSIZE	Total farm size in hectares	+	2SLS/THM
Transaction Cost Variables			
DISTMKT	Distance to nearest market in kilometres	-	2SLS/THM
OMT	Own means of transportation/Dummy(1=Yes, 0= No)	+	THM
AMI	Access to market information/Dummy(1=Yes, 0= No)	+	2SLS/PBRs
GRN	Good road network/Dummy (1=Yes, 0=No)	+/-	THM
Resource Endowments/Institutional Factors (Private and Public Assets and Services)			
T_OUTPUT	Total volume of cowpea produced in kilograms		PBR/TRR
T_INCOME	Total household farm income in Ghana Cedis	+/-	2SLS/THM
OFI	Off-farm income in Ghana Cedis	-	THM
LABOUR	Farm labour use in man-days	+	2SLS/PBR
LANDOWN	Landownership type/Dummy (1=Own land, 0= No)	+	THM
LIVESTOCK	Value of owned livestock in Ghana Cedis	+	2SLS/THM
COWVAR	Access to improved cowpea seed/Dummy (1=Yes, 0=No)	+	2SLS/THM
TRACPLOUGH	Access to tractor services for ploughing /Dummy (1=Yes, 0=No)	+	2SLS/PBRs
CREDIT	Access to credit/Dummy (1=Yes, 0=No)	+	2SLS/THM
EXT	Access to extension service/Dummy(1=Yes, 0=No)	+	2SLS/PBR
Market Price			
COWPEA PRICE	Selling price per bowl of cowpea in Ghana Cedis	+	2SLS/THM
Location Variables			
TOLON	Household in Tolon/Dummy (1=Yes, 0=Otherwise)	+/-	2SLS/THM
KUM	Household in Kumbungu/Dummy (1=Yes, 0=No)	+/-	2SLS/THM
MION	Household in Mion/Dummy(1=Yes, 0=Otherwise)	+/-	2SLS/THM
YENDI	Household in Yendi/Dummy(1=Yes, 0=Otherwise)	+/-	2SLS/THM

Household characteristics

Household characteristics are denoted by five controlled variables, which are, the age (*AGE*), gender (*GENDER*), educational level (*EDUY*), dependency ratio (*DEPRATIO*) and farm size (*FSIZE*). Age is expected to have positive association with production, participation in agricultural market and productivity. The hypothesis is that older farmers are expected to be more experienced in production and marketing decision making. Male smallholder farmers are perceived to have more access to productive assets such as land, labour and capital which increases their production capabilities and hence, a positive relationship is expected with production, productivity and market participation. Educational attainment enhances smallholder farmers' prospects of obtaining and processing market information accurately (Makhura, *et al*. 2001) as well as adoption of productivity enhancing techniques and thus, a positive relationship with production, market participation and productivity are expected.

Dependency ratio is expected to positively influence productivity, decision to produce and market participation since the lesser this ratio, the higher the availability of active labour force in the household to engage in production and market participation activities. According to Olwande & Mathenge (2012), farm size may have indirect positive impacts on productivity and market participation. Larger farm size enables farmers to create marketable surpluses, surmount cash constraints in situation where land can be used as collateral for credit, and permit farmers to embrace improved technologies that increase productivity. Therefore positive relationship is expected between farm size and productivity, decisions to produce and market participation decisions.

Transaction costs variables

Transaction costs variables are the key market participation and intensity of participation determining variables. These variables according to Key *et al*. (2000) are mostly not observable in survey data and are therefore represented with proxy variables hypothesised to be observable factors that represent them. Two of these variables were used as candidate instruments for the intensity of market participation (proportion of output sold) hypothesised to be endogenous in the productivity model, and they affect productivity only through participation in the market. These variables include ownership of means of transportation (*OMT*) and proximity to all-weather good road (*GRN*). The plausibility of each of these instrumental variable and their legitimacy is dependent on the extent to which it is associated with farmers' productivity through their participation in the market and not any production relationship directly (Rios *et al.* 2009). These two variables were used as instrumental variables in the 2SLS estimation and as explanatory variables in the THM.

Other transaction costs variables such as access to market information (*AMI*) and distance to nearest market (*DISTMKT*) are expected to affect production, productivity and market participation. With distance to nearest market, the hypothesis is that, the longer the distance to the nearest market, the lesser the production, selling orientation of the smallholder and hence the lower will be their productivity. The rest of the variables are also expected to positively influence market participation. For example, ownership of means of transportation reduces the marginal cost of movement, access to market information also reduces the problem of information asymmetry in the market place, viability of access roads influence the speed and cost of transportation. Literature however, reports diverse inferences on the correlation between good road infrastructure and market participation decisions. While some studies Boughton *et al.* (2007), Goetz (1992), Key *et al.*

(2000), Heltberg & Tarp (2001) and Renkow *et al*. (2004) report infrastructure as an influential factor in market participation, studies by other authors such as (Lapar *et al.* 2003; Holloway & Lapar 2007) indicate that infrastructure is not correlated with market participation decisions. Moreover, this perceived relationship between infrastructure and sales-orientation is found to vary among sellers and buyers (Goetz 1992; Key *et al*. 2000).

Resource endowments (private and public assets and services)/Institutional factors

Resource endowment factors of production measure the wealth of the farm households. Possession of productive assets (private and public assets) and services are mentioned as important factors of agricultural production (Rios *et al*. 2009; Schultz, 1964) and market participation (Boughton *et al.* 2007). Private and public assets variables and service variables used as controlled variables in both models include total household production (*T_OUTPUT*), total household income (*T_INCOME*), household off-farm income (*OFI*), and labour usage (*LABOUR*). The rest include possession of own land by the household head (*LANDOWN*), value of owned livestock (*LIVESTOCK*), access to credit (*CREDIT*) and access to extension services (*EXT*). Income obtained from trading activities may influence market participation and productivity since farmers are able to devote some of this income to production expenditure such as purchase of farm inputs. Therefore the effect of total income on productivity and market participation decisions is expected to be indefinite. The greater the volume of total output produced the greater the propensity to sell and therefore positive relationship is expected between total output and market participation decisions. The higher the value of off-farm income, the lesser the time apportioned to farming activities resulting in lower production and market participation decisions (Rios *et al.* 2009).

The number of man-days (labour) expended on cowpea production activities can potentially positively raise the productivity level of farmers and by extension their market participation activities. Having secured rights to land is mostly promoted as an avenue for generating incentives for farmers to invest in technologies and practices that engender land conservation and raise productivity in the long-run (Pingali & Rosegrant, 1995; Rios *et al.* 2009). Consequently, having own land for farming activities is likely to positively affect market participation decisions. Similarly, value of owned livestock, access to credit and extension services are potential variables that positively influence market participation and productivity (Minten & Barrett, 2008). It is however expected that the more visits the extension service provider pays to the farmers, the more likely the farmer would produce and increase productivity.

Access to improved cowpea variety for cultivation (*COWVAR*) and access to tractor for ploughing (*TRACPLOUGH*) are also expected to positively influence productivity, the decision to produce and market participation decisions.

District market price

District market prices of cowpea output denoted as (*COWPRICE*) is expected to positively affect the intensity of smallholders farmers' sales-orientation and productivity, as theorised by Key *et al*. (2000) and Alene *et al*. (2008). This variable measures the selling price of cowpea in the market.

Location variables

The unobserved location-specific effects were controlled using the districts as dummy variables. These dummies were incorporated in the models as controlled variables to address dissimilarities in the overall disparities in economic and social conditions of the various communities. These location-specific disparities refer to infrastructure, inaccessibility, resource endowment,

production potential and farming conditions across districts. The relationships the results from these dummies revealed are to be explained by the specific characteristics and attributes of each of the location following from Mmbando *et al.* (2015). The dummy for Tolon district (*TOLON*) was used as a reference and was left out of the model to avoid the dummy variable trap. Tolon was used as the reference variable because it was identified to be the largest producer of cowpea as shown in the results in table 4.6.

3.6 The Study Area

The Northern Region is predominantly an agrarian region occupying an area of about 70,384 square kilometres making it the largest region accounting for 29.5% of the total land area of Ghana and regarded as one of the poorest and least developed regions. The total population of the region based on the Population and Housing Census of 2010 stood at 2,479,461 with females (1,249,574) representing 50.6% and males (1,229,887) representing 49.6%. The region was described as the fastest growing region in the country having a population increase of 38.1% between 2000 and 2010 more than the other region in the country. The mainstay of the people in the region is agriculture evidenced by the fact that 71.2% of the economically productive group are engaged in agriculture. They are largely subsistence food crop producers with most of the populace living in rural areas. The major crops grown are maize, yam, groundnut, cowpea, rice, millet, sorghum and soybeans. The region has twenty-five administrative districts. The study focused on four of these administrative districts namely Tolon, Kumbungu, Mion and Yendi which are among the top ten cowpea producing districts in the Northern Region (MoFA-SRID, 2016).

The Tolon district lies between latitudes 9^0 15` and $10^0$ 02` North and Longitudes 0^0 53`and$1^0$ 25` West. It shares boundaries to the North with Kumbungu, North Gonja to the West, Central Gonja

to the South, and Sagnarigu Districts to the East. According to the 2010 Population and Housing Census, the District's population stands at 72,990 comprising of 36,360 males and 36,630 females. Agricultural production accounts for about 74% of the district's labour force reflecting the agrarian nature of the economy. According to the District Directorate of Agriculture, the total area cultivated for cowpea in 2013 production season was 3,300 hectares with a yield of 2 metric tonnes per hectare making it one of the most cultivated crops in the district. Marketing of farm produce however remains a major challenge due to inaccessible farms and marketing centres.

The Kumbungu district shares boundaries to the North with Mamprugu/Moagduri district, Tolon and North Gonja districts to the West, Sagnarigu District to the South and Savelugu/Nanton Municipal to the East. The total population of the district is 55,412 with males representing 50.1% and females 49.9%. The district is entirely made up of rural farming communities with most of them having populations less than 500. Agricultural production is the main economic activity in the district and is practised mainly on seasonal and subsistence level with a few engaged in irrigation farming around the Bontaga Dam. Across the district, most people cultivate food crops like maize, rice, groundnuts, yam, and cowpea among others. The problem of marketing of farm produce is challenge facing most farmers in the district.

The Mion district is located in the Eastern corridor enclave of the Northern Region of the Republic of Ghana. It shares boundaries with Yendi Municipal to the East, Tamale Metropolitan and Savelugu Municipal to the West, Gushegu and Karaga to the North and Nanumba North and East Gonja to the South. The population of the district, according to the 2010 Population and Housing Census, is 81,812 with relatively more females (50.3%) than males (49.7%). The Economy of the people is largely subsistence with agriculture being their main occupation with over 95% of the

people depending on agriculture for their livelihood. The major food crops cultivated include maize, yam, rice, millet, groundnut, cowpea and soyabean.

The Yendi municipality is also located in the Eastern corridor enclave of the Northern Region. It lies between Latitude 9^0–35^0 North and 0^0–30^0 West and 0^0–15^0 East. The Municipality shares boundaries with six (6) other District Assemblies; to the East; Saboba District, Chereponi District and Zabzugu District, to the South Nanumba North District, to the North Gushegu District and Mion District to the West. According to the 2010 Population and Housing census, the population of the Municipality is 117,780. Out of the total population, 50% are males and females (50%). The majority of the people in the municipality are involved in subsistence agriculture with over 80 percent of the people depending on agriculture for their livelihood. Cultivation of cowpea is among one of the numerous farming activities undertaken by the inhabitants of the municipality.

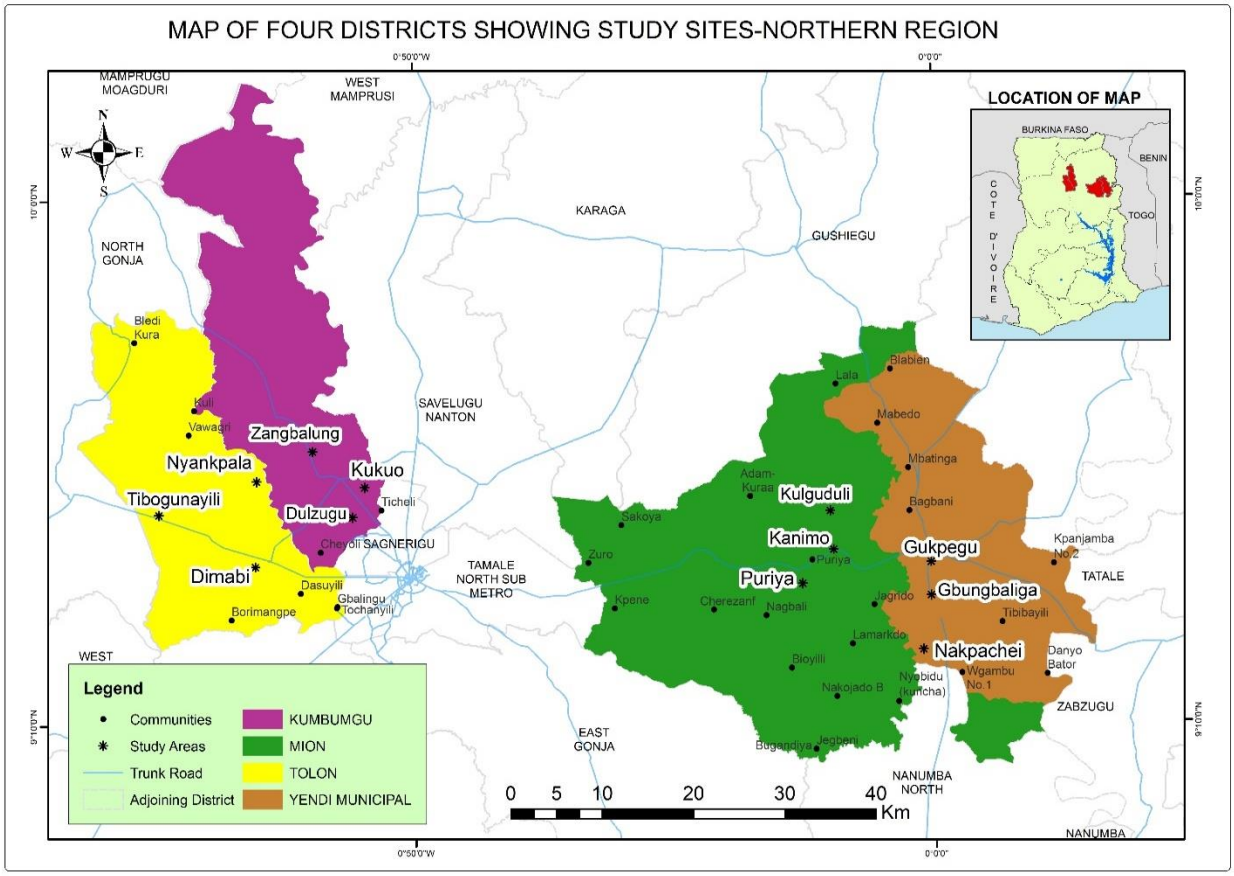

Figure 3.4: Map of the Study Area Showing Sampled Districts and Communities
Source: CERSGIS, University of Ghana, Legon, 2018.

3.7 Methods of Data Collection

This section presents the sources and types of data collected for the study. It also presents the sampling approach adopted and the sample size used for the analyses.

3.7.1 Sources and types of data

Primary cross-sectional data were mainly used for the study. The primary data were collected using a household survey semi-structured questionnaire administered through an interview of smallholder cowpea producers and non-cowpea producers.

The questionnaire was designed to collect an extensive range of data on volume of cowpea produced by producers, farmer characteristics such as age, gender, farm experience, and household size, among others. Data on resource endowments that capture both public and private assets variables, and services variables such as, off-farm income, access to tractor services for ploughing and access to improved cowpea seed were also collected. Transaction costs variables including distance to markets, ownership of means of transportation among others were also collected. Non-cowpea producers were also identified and interviewed.

3.7.2 Sample size and sampling approach

The main population for the study comprised smallholder farmers (farmers who cultivate at most 2 ha of cowpea during the study period). All cowpea farmers who produced on more than 2 ha land holding of cowpea are excluded from the sample and therefore not considered as a smallholding. A cowpea farmer for the purpose of this study is a farmer who produces cowpea as a monocrop or as an intercrop. A non-producer on the other hand is a farmer who does not produce cowpea but has the potential to produce the crop. A sample size of 300 comprising of 240 producers and 60 non-producers were purposively and randomly sampled for the study. Sixty (60) cowpea producers and fifteen (15) non-producers were selected from various communities in each of the four (4) districts to make up the total sample size of three hundred (300). This sample size was chosen partly for logistical considerations and it is large enough to make generalisations about the population of interest in the Northern Region of Ghana.

A multi-stage sampling as well as key informants interview approaches were adopted for the study. The multi-stage procedure is a three-stage; clustered, purposive and randomised sampling procedure. The three stages involve selection of the districts, communities, and lastly, selection of

cowpea producers and non-producers. In the first clustering stage, four farming districts were purposively selected based on the fact that they are among the top ten cowpea producing districts in the Northern Region of Ghana. In the second stage, twelve (12) communities, three (3) from each district were selected purposively based on their production potential of cowpea. This purposive selection was done in broad discussions with district officers of MoFA. This was to prevent a random sample of communities where cowpea is not intensively produced. The third and final stage involves randomly selecting respondents from the communities chosen in the second stage. It is envisaged that identification of smallholder cowpea farmers will be difficult. Therefore, in order to overcome this challenge, a communal place (a place where farmers normally congregate as it is the case in most farming communities in the Northern Region) was used as the reference point for preparing a list of smallholder farmers. The list generated was then used as the basis for the sampling. Female smallholder cowpea farmers were identified by finding out from their male counterparts females who are also into cowpea production and also through key informants. Key informants interviews also led to the identification of non-cowpea producers.

Table 3.2: Sampled Districts, Communities and Sample Size

District	Communities	Sample Size	
		Producers	Non-Producers
Tolon	Nyankpala	20	5
	Tibogunayili	20	5
	Dimabi	20	5
Kumbungu	Kumbungu-Kukuo	20	5
	Dulzugu	20	5
	Zangballung	20	5
Mion	Puriya	20	5
	Kanimo	20	5
	Kulguduli	20	5
Yendi	Yendi Gukpegu	20	5
	Gbungbaliga	20	5
	Nakpachei	20	5

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and findings of the study. It begins with a detailed description of the demographic and socioeconomic characteristics of cowpea producers in the Northern Region. Detailed descriptions and summary statistics of continuous and binary variables used for the analyses as well as farm and district characteristics are also presented. Also, productivity and market participation characteristics in the Northern Region are discussed and presented. Finally, the results of the determinants of cowpea productivity, production and market participation decisions are identified and discussed.

4.2 Descriptive Statistical Analyses of Farmer and Socio-economic Characteristics

This section presents the descriptive analyses aspect of the results and discussion. It describes the sample distribution of smallholder cowpea producing households in the region, the general farmer and socio-economic characteristics of the sampled smallholder households. The section also describes cowpea production, productivity and marketing characteristics of the respondents.

4.2.1 Sampled distribution of smallholder cowpea households in the northern region

The sampled distribution of smallholder cowpea households in the region includes 240 cowpea producers and 60 non-producers. Ideally, there are expected to be more non-producers of cowpea in the region than sampled. However, the figure of 60 used for the study is statistically reasonable to make valid conclusions and inferences regarding cowpea production participation decision. Eighty percent of the sampled smallholder farmers are producers and 20% are non-producers. All of the interviewed cowpea producers are smallholder farmers with less or approximately 2 hectares

of farm size. Furthermore, of the 240 cowpea producers, 76.25% are market participants and 23.75% are non-participants. Table 4.1 displays these statistics.

Table 4.1: Production and Market Participation Behaviour of Smallholder Farmers

Cowpea Production and Market Participation	Frequency	Percentage
Cowpea production		
Producer	240	80.00
Non-producer	60	20.00
Total	300	100.00
Cowpea market participation		
Market participant	183	76.25
Non-market participant	57	23.75
Total	240	100.00

Source: Computation from Household Survey, 2018.

4.2.2 Farmer and socio-economic characteristics of sampled households

This section discusses the demographic and socio-economic attributes of cowpea producing households. The characteristics discussed are age, gender, household size, religion, ethnicity, educational attainment, experience in farming and farm size of household heads. The results of these descriptive statistics are presented in table 4.2

Age Distribution of Household Heads

From Tables 4.2 and 4.3, the age of distribution of smallholder farmer households ranges from a minimum of 18 to a maximum of 78. Majority 58.9% of households are within the age bracket of 18-35 years, 31.2% are between the age bracket of 36-40 years while 4.9% are respectively within the age bracket of 51-60 and 60 and above years. Generally, 95% of the sample is within the economically active age range 18-60. This presents prospects for developing agriculture in the Northern Region. The mean age is about 36 years with majority of them falling in the 90th percentile implying that family units in the Northern Region can be described as belonging to the youthful category and within the economically active population age bracket. This has implication

for agricultural development since according to Polson & Spencer (1992), active smallholder farmers are more amenable to adoption of technologies and innovations.

Gender of Household Heads

The result of gender distribution is displayed in table 4.2. About 90% of smallholder farmers are males while about 10% are females. This finding is in line with the gender distribution of households in Ghana where 65.3% are male dominated and 34.7% are dominated (GSS, 2012).

Household Size of Households

From tables 4.2 and 4.3, the mean household size of farm households in the region is about 13 people ranging from 3 to 45. This average household size is higher than the GSS-Ghana Population and Housing Census (2012) average of 7.7 for the region and also higher than the 2012/2013 Ghana Living Standards Survey (GLSS) Report (2014) average of 5.4 for the region. The reason for this variation is attributed to the composition of the sample. Agriculture based households especially smallholders are located in the rural areas where the household sizes are quite large. About 36% of households have size between 6 to 10 people, 30% with size between 11-15 people, 23% having size of over 15 while about 12% have size of between 1-5 people. Martey *et al.* (2012) reported that, one potential for having large household size is that it frees up family labour for production. Also, Abu *et al*. (2016) and Al-Hassan (2008) argue that large families enable household members to earn additional income from non-farm activities. This notwithstanding, large household can reduce the amount of marketable surplus a household can raise to participate in the market. This is apparent in the observation of Abu *et al*. (2016) and Makhura *et al.* (2001) that the decision to sell is preceded by a decision to consume.

Religious Distribution of Household Heads

The majority (79.6%) of the smallholder farmers profess the Islamic faith. This is followed by smallholders who are Muslims 18.3%. Farmers practicing the traditional religion are 5 representing 2.1%. This statistic was not found to have any meaningful economic impact on cowpea production in the study area since most smallholder farmers produce the crop without recourse to their religious persuasion.

Ethnic Distribution of Household Heads

In Tables 4.2 and 4.3, the dominant ethnic group in the sample is the Dagombas representing 78% of the sample. This large representation is expected since the Dagombas predominantly occupy more than half of the population of the Northern Region and also constitute the major ethnic group in the Tolon, Kumbungu, Mion and Yendi districts. Konkombas are the second largest group in the sample representing 21.8% who are settled mostly in communities in the Mion district, Gonjas and Frafras represent 0.4% and 0.8% of the sample respectively.

Table 4.2: Farmer and Socio-economic Characteristics of Surveyed Households

Characteristics	Min	Max	Frequency	Percentage
Age	18	78		
18-35			141	58.9
36-40			75	31.2
51-60			12	4.9
60+			12	4.9
Gender				
Male			216	89.6
Female			24	10.4
Household Size	3	45		
1-5			28	11.8
6-10			86	35.9
11-15			71	29.6
15+			54	22.9

Table 4.2: Farmer and Socio-economic Characteristics of Surveyed Households cont'd

Characteristics	Min	Max	Frequency	Percentage
Religion:				
Islam			191	79.6
Christian			44	18.3
Traditional			5	2.1
Ethnicity				
Dagomba			187	78.0
Konkomba			50	21.8
Gonja			1	0.4
Frafra			2	0.8
Education	0	20		
No Schooling			169	70.4
Primary			21	8.8
JHS/MSCL			20	8.3
SHS/Technical/Vocational			19	7.9
Tertiary			11	4.6
Farm Size	0.2 ha	2 ha		
0.2-0.8 ha			172	71.6
1.0-2.0 ha			68	28.4

Source: Computation from Household Survey, 2018.

Educational Status of Surveyed Households

Majority of the smallholder households (70.4%) have no formal education. Smallholders with primary level of education were 8.8%. Those with Junior High/Middle School education represent 8.3%, Senior High/Technical/Vocational level of education represent 7.9%. Smallholder farmers with tertiary level of education is the least represented at 4.6%. The mean years of education is (2.91) as showed in Table 4.3. The result shows that on average the highest level of education attained by a smallholder farmer is three (3) years indicating a primary level of education

The result is consistent with the finding of the GSS (2008) that about half of adults in Ghana neither attended school nor completed middle school/JSS. This could have some negative repercussion on agriculture in terms of adoption of productivity enhancing operations and understanding of market

dynamics. Also, according to Minot *et al.* (2006) education is a means of entry into extra employment activities especially in the non-farm sector. With majority of heads in the region without formal education it can be postulated that most of these people would not be able to sufficiently engage in formal non-farm activities. The low level of education exhibited by the respondents could also affect negatively the prospects of engaging fully in the market and adopting productivity enhancing technologies.

Farm Size

As indicated in Tables 4.2 and 4.3, the mean farm size under cowpea cultivation is 0.84 ha and a minimum of 0.20 ha. The maximum farm size under cowpea production was found to be approximately 2 ha. Majority (71.6%) of the farm sizes range between 0.2-0.8 ha, while farm sizes between 1.0-2.0 ha represented 21.8%. Farm size of approximately 2 ha represented 28.4% of smallholder cowpea farmer's landholding distribution in the Northern Region of Ghana. These distributions indeed shows the smallholding characteristic of cowpea farming in the Northern Region, thereby becoming a disincentive for producing higher marketable surplus since according to (Martey *et al.* 2012), higher farm sizes serve as an inducement to produce more marketable surpluses.

4.2.3 Distribution and summary statistics of the variables used in the analyses

Tables 4.3 and 4.4 show the distribution and summary statistics of the variables used in the analyses for cowpea production, productivity and market participation.

Distance to Market and Good Road Network

Table 4.3 shows that, the mean distance to the nearest main market for cowpea farmers in all the four districts was found to be 7.45km with a corresponding standard deviation of 4.73km. The

shortest distance to market was found to be 2km with the longest distance being 20km. It is therefore evident from this finding that cowpea farmers are quite far away from the marketing centres. Furthermore, from Table 4.4, majority of the respondents (65%) indicated that the major road linking their communities to the nearest market centre is not motorable or not in good shape.

Total Income and Cowpea Price

Total household income refers to the total amount of earnings a household possesses. The total income possessed by the sampled smallholder farmers was found to be four hundred and seventy-two thousand, eight-hundred and fifty-two Ghana Cedis (GHS 472, 852.00) with a mean income of One thousand, nine hundred and seventy Ghana Cedis (GHS 1970.00). This amount was obtained from the sale of total output of 82,461kg of cowpea grain. The minimum price farmers obtained from the sale of a bowl (3kg) of cowpea is GHS 2.50 and the maximum price obtained was found to be GHS 15.00 per bowl. The mean price was GHS 6.8 per bowl of cowpea.

Off-farm Income

The total off-farm income for the sampled farmers as indicated in table 4.3 was found to be Eighty-two thousand and eighty Ghana Cedis (GHS 82,080.00) with a mean of approximately Three hundred and thirty-two Ghana Cedis (GHS 342). This low participation in especially formal non-farm income activities could have arisen as a result of the fact that majority of the smallholder cowpea producers are without formal education.

Value of Livestock Owned

The result indicates that One hundred and ninety-five (195) of the smallholder farmers representing approximately 81% owned livestock. The value of livestock owned by these farmers was found to be Seventy-nine thousand, one hundred and sixty-eight Ghana Cedis (GHS 79,168.00) with a mean

value of Three hundred and thirty Ghana Cedis (GHS 330.00). Smallholder cowpea farmers in the Northern Region are into diversified farming activities by also engaging in livestock production.

Ownership of Own Means of Transportation

Results from Table 4.3 show that majority of the sampled smallholder farmers (52%) had access to their own means of transportation. These include motor-king, bicycle and motor bikes since these equipment are the most populous means of transportation in the Northern Region. Having access to own means of transportation facilitates movement to farm and marketing centres among smallholder farmers in the Northern Region.

Access to Market Information

As indicated in table 4.3, it is obvious that majority of the smallholder farmers (67%) often access market information relating to input and output prices in the market. This finding is supported by the fact that majority of the farmers (88%) had access to mobile phone since it provides a major means of communication and acquiring information. Therefore most cowpea farmers in the Northern Region regularly access market information when it comes to making production and market participation decisions.

Table 4.3: Description of Explanatory Continuous Variables used in Analyses

Variable	Percentile				Mean	SD
	25	50	75	90		
Age (years)	28	34	45	55	36.33	12.36
Household Size	8	11	15	24.50	13.09	7.69
Dependency Ratio	0.51	0.91	1.50	2.50	1.17	0.98
Education (years)	0.00	0.00	6.00	12.00	2.91	4.88
Farm Size (hectares)	0.40	0.80	1.20	1.60	0.84	0.51
Distance to Market (km)	4.80	5.00	8.00	16.00	7.45	4.73
Total Income (GHS)	900	1355	2377.5	4300	1970	1753
Off-farm Income (GHS)	0.00	0.00	200	1000	342.00	934.91
Livestock (GHS)	120	240	330	600	210	312.74
Labour (man-days)	23	32	480	720	329.87	351.31
Cowpea Price (GHS)	6.00	7.75	9.00	10.00	7.57	2.00

Source: Computation from Household Survey, 2018.

Access to and Cultivation of Improved Cowpea Seed

As indicated in Table 4.3, majority of the smallholder farmers (83%) had access to improved cowpea variety for cultivation. These varieties were principally obtained from the Savannah Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR) while others obtained their improved variety from the Ministry of Food and Agriculture (MoFA). Some of the farmers also reported buying these improved seeds from input dealers.

Tractor Services for Ploughing

Table 4.3 also indicated that smallholder farmers who had access to tractor services for ploughing their fields were only (31%) of the sampled population. The implication of this low tractor

ploughing access is that these farmers have to mostly depend on own labour and sometimes family labour in clearing their fields thereby restricting their ability to expand production. This may also significantly impact their level of productivity and market participation since possession of farm assets had been identified as a means of enhancing agricultural productivity and commercialisation (Asfaw *et al*. 2012; Wickramasinghe, 2015).

Table 4.4: Description of Explanatory Binary Variables used in the Analyses

Variable	Mean	SD
Gender	0.90	0.30
Own means of transportation	0.52	0.50
Access to market information	0.67	0.47
Proximity to good road network	0.35	0.47
Ownership of mobile	0.88	0.32
Ownership of radio	0.63	0.48
Land ownership Type	0.63	0.48
Access to credit	0.22	0.42
Access to extension services	0.65	0.48
Access to improved cowpea seed	0.83	0.38
Access to tractor services for ploughing	0.31	0.46

Source: Computation from Household Survey, 2018.

4.2.4 Cowpea productivity and market participation characteristics of households

Table 4.5 displays the summary of gross value of cowpea produced per hectare per sampled districts. Tolon district had the higher level of farm productivity with a mean productivity of 1,618.88 Ghana Cedis per hectare as compared to the other districts with a mean productivity value almost as twice that of the closest district Mion with 860.18 Ghana Cedis per hectare. The mean

productivity level found in Kumbungu and Yendi districts were respectively less than twice that of Tolon. This heterogeneity in productivity levels is not attributable to differences in agro climatic conditions since almost all districts in the Northern Region experience the same seasonal variations in weather conditions.

The apparent causation could be that cowpea producers in Tolon district are more efficient in their productions, produce higher output per farm size and obtain better value for their cowpea grains than their counterparts from other parts of the region. Geographical variation arising as a result of access to well-endowed input markets and technology opportunities could also be a factor. Kumbungu district was however found to have the lowest level of cowpea productivity.

Table 4.5: Gross Value of Cowpea Produced per Hectare by each Sampled District

District Name	Gross Value of Cowpea Produced (GHS/Ha)	Mean Productivity
Tolon	97132.80	1618.88
Kumbungu	36142.80	602.38
Mion	51610.80	860.18
Yendi	39278.40	654.64
Total	224164.80	56041.20

Source: Computation from Household Survey, 2018.

4.2.5 Cowpea productivity level and market participation per sampled district

Figure 4.1 and Table 4.6, show the summary of the resultant productivity level and proportion of output sold in the markets. For Tolon and Mion districts, the higher the level of productivity the greater the proportion of output sold in the markets. But the same conclusion cannot be made between Kumbungu and Yendi. Though farmers in Kumbungu had lower level of productivity than Yendi, they however had greater marketable surpluses than their counterparts from Yendi.

What this means is that cowpea producers in Yendi produce more for household consumption than for sell in the markets and therefore having higher level of productivity does not necessary mean increased level of market participation.

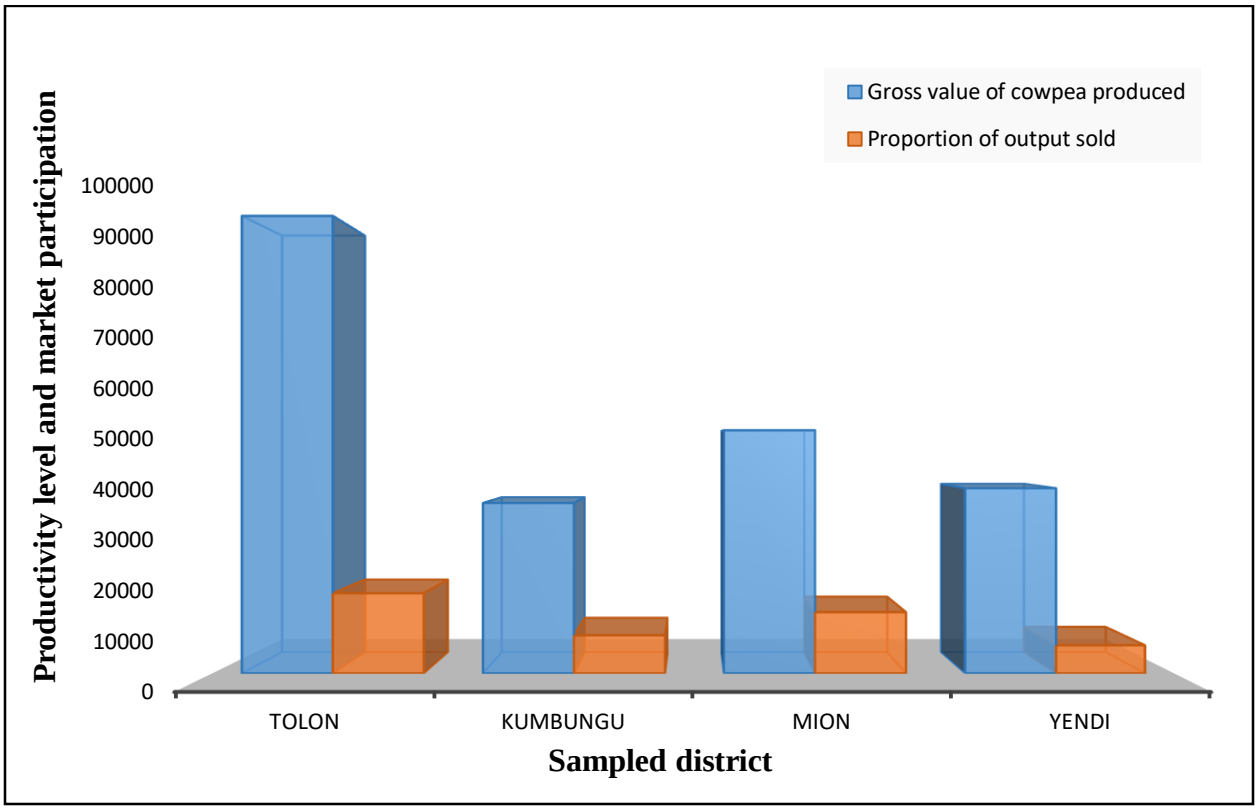

Figure 4.1: Productivity Level and Proportion of Output Sold per Sampled District
Source: Computation from Household Survey, 2018.

Table 4.6: Cowpea Productivity and Proportion of Output Sold per Sampled District

District	Productivity	Output produced	Output sold	Proportion sold
Tolon	97132.80	35544	16977	47.76
Kumbungu	36142.80	13785	8058	58.45
Mion	51610.80	18699	12984	69.44
Yendi	39278.40	14313	5952	41.58
Total	224164.80	82341	43971	

Source: Computation from Household Survey, 2018.

Table 4.7 below displays the Chi-Square test of differences in level of proportion of output sold among market participants in the four sampled districts. The test results indicate a 1% significance level for all the four districts. This result therefore shows that on the average, a significant proportion of the total cowpea production by smallholder farmers in the Northern Region is sold in the market by the producers.

Table 4.7: Chi-Square Test of Differences in Levels of Proportion of Output Sold

District	Proportion sold	Chi-Square	Significance level
Tolon	47.76	145.33***	0.000
Kumbungu	58.45	96.60***	0.000
Mion	69.44	64.20***	0.000
Yendi	41.58	145.20***	0.000

Source: Computation from Household Survey, 2018

4.2.6 Aggregate productivity and market participation of smallholder producers

The regional aggregate gross value of cowpea produced per hectare from Tolon, Kumbungu, Mion and Yendi districts was computed to be 224,164.80 Ghana cedis per hectare. The aggregate market participation of smallholder cowpea producing households from the data collected showed that the marketed surplus ratio is 53.4%. These imply that 53% of the produce from cowpea were sold by the sampled smallholder producers in the Northern Region during a planting season on average. The average marketed surplus ratio for all crops and for only cowpea estimated by IFPRI (2011) and Franke & de Wolf (2011) were 34% and 40% respectively for the Northern Region. Musah *et al.* (2014), also reported a 24% surplus ratio for maize in the Upper West Region of Ghana. The results indicate that the surplus ratio estimated for cowpea is therefore 19% point higher than the average marketed surplus ratio estimated for all crops by IFPRI (2011), and 13% and 29% point higher than the estimates by Franke & de Wolf (2011) and Musah *et al.* (2014) respectively. This findings therefore show that cowpea is cultivated mostly for cash and not just as a staple for household consumption in the Northern Region of Ghana.

4.3 Analytical Estimations of Cowpea Production, Productivity and Market Participation

This section focuses on the analytical estimations aspect of the results and discussions. It begins by testing for multicollinearity, heteroskedasticity and endogeneity in the variables used for the estimations. It also presents results and discussions for the factors influencing smallholder farmers' decision to produce cowpea and the factors influencing smallholder farmers' decision to participate in the markets. The results and discussions for the factors influencing the intensity of market participation of smallholder cowpea producers are also presented. Finally, the section also

presents the results and discusses the effect of intensity of market participation on productivity of smallholder cowpea producers in the Northern Region.

Test for multicollinearity and heteroskedasticity in the THM variables

Prior to the estimations, the variables used for the THM analysis were first checked for the possible presence of multicollinearity and heteroskedasticity which are common phenomena in most regression analysis. The Variance Inflation Factor (VIF) test for multicollinearity indicated a value less than the critical value of 10 (Gujarati & Porter, 2009; Mmbando *et al*. 2015; Shiferaw *et al*. 2008), confirming that multicollinearity was absent. The Breusch-Pagan/Cook-Weisberg test for heteroskedasticity was also conducted. The result indicated no presence of heteroskedasticity, since the calculated χ^2 value of (2.75) was smaller than the tabulated χ^2 value of (3.84) at the 5% level of significance and one degree of freedom following from Mmbando *et al*. (2015).

Though the triple hurdle model can be estimated separately using Heckman's (1979) method, simultaneous estimation via the maximum likelihood method allows for easy calculation of predictive margins and partial effects of explanatory variables (Gebremedhin *et al.* 2017). Therefore the mixed-process regression approach which allows for different equations with different kinds of dependent variables or response types to be fixed simultaneously was used following from Roodman, (2011). The user written command, *"cmp"* by Roodman (2011) was then used for fitting the estimation in Stata version 15.

The Triple Hurdle model also assumes that the error terms in the three models are uncorrelated. To test this assumption a restricted model is estimated by setting the correlation among the error term to zero and a likelihood ratio (LR) test was performed by comparing the unrestricted model to the restricted model. The result from the likelihood ratio test indicates that the unrestricted model

is preferred to the restricted model χ^2 (4) = 286.92, p = 0.0000. In addition, the LR test of the hypothesis that all regression coefficients are jointly equal to zero is also highly rejected. These show that not accounting for the two-sample selection biases would result in wrong inferences (Gebremedhin *et al.* 2017).

Following exclusion restrictions used in similar models (Azam *et al*. 2012; Boughton *et al*. 2007; Burke *et al.* 2015; Gebremedhin *et al.* 2017), in identifying the second stage equation of the decision to participate in the cowpea markets, labour measured in mandays was used as an exclusion restriction variable. This variable was identified to be statistically significant in the production model (p =0.026), but was conceptually and empirically irrelevant in stage two (market participation decision model) (p = 0.490). Similarly, distance to nearest market was used as an exclusion restriction variable to identify the third stage equation of intensity of market participation in the output markets. Distance to market was statistically significant in stage 2 (p = 0.034), but was not significant in stage 3 (p = 0.322).

Table 4.8 presents the maximum likelihood estimates of the three-stage cowpea production and market participation decision models. Column (i) presents coefficient estimates for factors associated with the probability of producing cowpea (stage 1). Column (ii) presents coefficient estimates for participation in the cowpea market conditional on being a cowpea producer (stage 2). Column (iii) presents results of the cowpea supply function for cowpea market participating producers (stage 3).

Table 4.8: Triple Hurdle Model (THM) Estimates of Cowpea Production, Market Participation and Intensity of Market Participation

	Stage 1: Production	Stage 2: Market participation	Stage 3: Intensity of participation (Proportion of Sales)
Variable	*Probit*	*Probit*	*Truncated regression*
Household Characteristics			
Age	-0.021*	-0.023*	-0.311**
	(0.063)	(0.067)	(0.037)
Gender	0.946**	0.382	1.712
	(0.018)	(0.303)	(0.814)
Dependency ratio	-0.381**	0.133	-0.357
	(0.009)	(0.307)	(0.847)
Education	0.022	-0.007	11.57**
	(0.431)	(0.757)	(0.007)
Farm size	0.161	0.116	-3.564
	(0.627)	(0.690)	(0.411)
Transaction Cost Variables			
Distance to market	-0.157***	-0.009**	-
	(0.000)	(0.034)	
Own means of transportation	0.629**	0.064**	0.792***
	(0.046)	(0.012)	(0.001)
Access to market information	0.140	0.402*	1.939
	(0.641)	(0.097)	(0.633)
Good road network	-0.679*	-0.147	11.640**
	(0.100)	(0.554)	(0.007)
Resource Endowments/Institutional Factors			
Total household production	-	0.004***	0.002
		(0.000)	(0.779)
Total household income	-0.000	-0.000	0.000
	(0.584)	(0.741)	(0.486)
Off-farm income	0.000	-0.000	1.259***
	(0.394)	(0.203)	(0.001)
Labour in mandays	0.023*	-	-
	(0.088)		
Own means of land	2.161***	-0.144	0.354
	(0.000)	(0.535)	(0.933)
Value of livestock owned	0.000	0.594**	1.662***
	(0.836)	(0.056)	(0.000)
Access to improved cowpea seed	0.164**	1.053***	0.988***
	(0.152)	(0.001)	(0.002)
Access to tractor for ploughing	1.329***	1.253***	-
	(0.001)	(0.002)	
Access to credit	0.358	0.106	-6.820
	(0.427)	(0.730)	(0.186)
Access to extension	0.534*	-	-
	(0.065)		

Table 4.8: Triple Hurdle Model (THM) Estimates of Cowpea Production, Market Participation and Intensity of Market Participation cont'd

	Stage 1: Production	Stage 2: Market participation	Stage 3: Intensity of participation (Proportion of Sales)
Variable	*Probit*	*Probit*	*Truncated regression*
Market Price Variable(s)			
Selling price of cowpea	-	-	-1.123
			(0.259)
District Location Dummies			
Yendi district	-0.548	-0.618	-0.179
	(0.312)	(0.258)	(0.650)
Mion district	0.061	0.405	8.6262
	(0.889)	(0.192)	(0.173)
Kumbungu district	-0.378	1.259***	3.903
	(0.315)	(0.001)	(0.408)
Constant	-0.119	-2.339**	3.917***
	(0.914)	(0.010)	(0.000)
Observations	300	240	183
Ancillary parameters			
σ		3.185***	
		(0.000)	
ρ_{12}		0.492**	
		(0.067)	
ρ_{13}		-0.095	
		(0.546)	
ρ_{23}		-0.219*	
		(0.095)	
Log likelihood		-983.854	
LR χ^2 (60)		225.43***	
		(0.0000)	

Source: Computation from Household Survey, 2018.
Notes: P-values in parentheses. *, ** and *** represent significance at 10%, 5%, and 1% respectively.
TOLON is the reference district dummy.

4.3.1 Factors influencing smallholder farmers' decision to produce cowpea

The Probit model for participation in cowpea production gave intuitive results. The coefficient for age was unexpectedly negative and significant at the 10% level of probability. This indicates that younger farmers are more likely to produce cowpea than older farmers. This can be explained from the labour intensiveness of cowpea production which often involves drudgery for older farmers. Furthermore, younger farmers are less risk averse and more amenable to new ideas and innovations

than older farmers and also have limited access to productive resources as reported by Awotide *et al.* (2013), Tabe-Ojong & Mausch (2017), Gebremedhin *et al*. (2017) and Bezu & Holden (2014).

As expected, gender showed a positive relationship with cowpea production with male smallholder farmers having a greater likelihood of engaging in cowpea production than female smallholder farmers. Statistically, on an average a male smallholder farmers are 0.95% more likely to engage in cowpea production than a female smallholder farmer. This could probably be attributed to the labour intensive nature of cowpea production such as land preparation, planting, weeding, and harvesting where men are able to overcome these arduous tasks better than females. They also have more access to land and other productive farm assets than their female counterparts and therefore the finding is not surprising.

Dependency ratio showed an unexpectedly negative relationship with cowpea production and statistically significant at 5%. The result reveals that an increase in dependency ratio by an additional member will likely decrease the probability of producing cowpea by 0.38%. This finding indicates that most households have higher dependency ratio. The result also suggest that household members are mostly within the inactive labour cohort and hence no additional labour is emanating from the household to be channeled into cowpea production.

Distance to the nearest market centre was expectedly found to have negative effect on cowpea production and statistically significant at 1%. This finding suggests that the longer the distance to the input market centre from the farming community, the less likely the participation in cowpea production. Statistically, an increase to the nearest input markets by a kilometre will reduce the probability or likelihood of engaging in cowpea production by 0.16%. This finding also reveals that long distances to input markets serve as a disincentive to farming households who cannot

easily travel to buy farm inputs. The results was found to be consistent with the findings of Lifeyo (2017) who also reported of similar relationship between distance to nearest market centre and common bean production in Malawi.

Ownership of own means of transportation was statistically significant at the 5% level of significance with the result also revealing that farmers who possess their own means of transportation are more likely to participate in cowpea production. The intuition is that these farmers are able to leverage production since they are able to reduce both the transaction cost and marginal cost of movement in getting to both the input and output markets.

Proximity to an all-weather good road network was found to have the expected sign. Smallholder cowpea producers who are not near to a good road network are less likely to participate in cowpea production. Statistically, smallholder cowpea producers who are far away from a good road network linking to an output market are 0.68% less likely to engage in cowpea production. Bad roads potentially increase travelling time and raise transportation or transaction costs. Binswanger *et al*. (1993), identified that improved roads contribute directly to growth in agricultural output in India.

As expected, labour used as a proxy to identify the market participation decision but irrelevant in the intensity of participation hurdle turned out to have a positive and significant effect on the probability of engaging in cowpea production. An additional increase in labour by a man-day by a household raises the probability of engaging in cowpea production by 0.02%. The result supports the assertion that labour is an important and critical factor of production. The finding is also consistent with Gebremedhin *et al.* (2017) who found the same relationship between labour and diary production in rural Ethiopia.

Having own land for cultivation of cowpea was found to be statistically significant at 1% and with the expected sign. The result reveals that cowpea producers who had own land for production are 2% more likely to participate in cowpea production than farmers who depend on hired land or family land for production. This finding indicates that farmers with own land do not share the output with anyone and therefore had the privilege of utilising their land in a manner they deemed fit. They can potentially increase production knowing they have no payment either in cash or in kind to any land owner. The result is in contrast with Lifeyo (2017) who identified a negative relationship between having access to own land and common bean production in Malawi.

Access to improved cowpea seed was also found to be significant at the 5% level of significance. The finding suggests that smallholder farmers who had access to improved cowpea seed are more likely to participate in cowpea production than farmers who do not have access to improved seed. The descriptive statistics suggests that about 83% of the respondents across the four districts accessed improved cowpea seed indicating the importance of making improved seed accessible and available to these smallholder farmers.

Farmers who often accessed tractor services for ploughing their fields before cultivation are approximately 1.3% more likely to participate in cowpea production than framers who had no access to tractor services. This finding suggests that farmers who accessed tractor services are able to reduce the time and the drudgery associated with manual weeding and clearing and therefore the opportunity costs associated with non-access to tractor services for field preparation are perceived to be greater and therefore serve as a disincentive in the production of cowpea in the Northern Region of Ghana. This finding also shows the importance of availability of farm equipment in cowpea production in particular and general agricultural production as a whole.

Access to extension services was also found to be statistically significant at the 10% significance level and with the expected sign. The finding however suggests that smallholder cowpea farmers who had access to extension services are 0.53% more likely to participate in cowpea production than farmers who had no contacts with an extension agent. After production decision has been made, extension services requirements are practically irrelevant as far as market participation decisions are concerned

4.3.3 Factors influencing cowpea market participation and intensity of participation

The coefficient of age was statistically significant at the 10% significance level though it did not support the a-priori theoretical expectation. The finding shows that on the average, an additional increase in age of a smallholder cowpea producer reduces the likelihood of participating in markets by approximately 0.02%. Conditional on the smallholder being a producer, and a participant in the market, age also depicted a negative relationship with the proportion of output sold in the market, by reducing the likelihood of sales by 0.3%. This result indicates that as smallholder farmers advance in age, they become more autarkic minded (producing for household consumption) than selling in the market. This is consistent with the findings of Goetz (1992), Tabe-Ojong & Mausch (2017), and Burke *et al.* (2015).

Although not significant in the market participation decision hurdle, smallholder farmers' level of education showed a positive and significant effect on the proportion of cowpea harvest marketed or sold. This can be attributed to the fact that advancement in education reduces search costs and increases the processing of information, thus reducing the fixed transaction cost. Education also increases social network which is vital for information access. This finding is in contrast with

Ouma *et al*. (2010) who identified a significantly negative impact of education on banana market participation in Rwanda and Burundi.

The coefficient of distance to market was statistically negatively significant as expected. This variable is included to proxy for fixed transaction costs and had a negative effect on the probability of market participation decision hurdle but not on the proportion of sale for a given seller. The result however indicates that each additional kilometre increase in the distance to the nearest market centre reduces the likelihood of participating in the market by approximately 0.009%. This supports the findings by Holloway *et al*. (2000), Holloway *et al*. (2004) for milk market participation in Ethiopian highlands, Staal *et al.* (1997) in Ethiopia and Wickramasinghe (2015) in Kenya. These findings also indicate that investment in market infrastructure is critical for market participation. The result reveals that the longer the distance to output market, the lower the likelihood of participating in the market by farmers. Theoretically, farm households located farther from a marketing centre rely on home-produced goods over market-produced goods and hence their degree of market participation reduces. Thus distance is a barrier to market participation (Wickramasinghe *et al*. 2014).

Conditional on a smallholder being a producer, those with own means of transportation have a 0.6% probability of participating in the market, whiles conditional on being a market participant, their intensity of market participation increases by 0.8%. This finding indicates that smallholder farmers' with own means of transportation are able to overcome the costs associated with market entry and therefore increase their participation in the market.

Access to market information was found to have a positively significant effect on market participation and at the 10% level of significance but insignificant in terms of the intensity of

market participation. This finding is supported by the fact that majority of the farmers (88% and 63%) had access to mobile phone and radio respectively which they depend on in acquiring market information services. The result therefore indicate that farmers who had access to market information are 0.4% more likely to participate in the market than those who had no access to market information. This result is corroborated by the finding of Goetz (1992) who obtained positive relationship between information and marketing behaviour of some selected households in Sub-Saharan Africa.

The coefficient of proximity to an all-weather good road network was found to be insignificant with the decision to participate in the market but had a positive and significant relationship with the intensity of market participation. The results indicate that households in communities nearer to a good road network (tarred road) had approximately 11.64% probability of marketing or selling their cowpea harvest than households not closer to a good road network. The implication therefore is that, having access to good road infrastructure reduces the transaction costs associated with getting to markets thereby serving as a stimulus for cowpea production and marketing in the Northern Region of Ghana.

Total output from cowpea production was found to be significant with market participation decision at the 1% level of significance. However, conditional on being a market participant, the correlation with the intensity of market participation was found to be insignificant. The interpretation of this finding is that for every kilogram increase in output, market participation decision is likely to increase by 0.004% supporting the findings of Tabe-Ojong & Mausch (2017).

Off-farm income unexpectedly showed a statistically positive relationship with intensity of market participation but had no significant correlation with market participation. The result reveals that

an increase in a household's off-farm income is likely to increase or encourage intensity of participation in the markets. This could be as a result of the fact that farmers with increased off-farm income activities had higher returns and are therefore encouraged to participate in the markets in order to again maximise returns from their farming activities. This finding is inconsistent with that of Seng (2016) who found a negative relationship with off-farm income activity and market participation in Cambodia, Rios *et al.* (2009) in their study on specific reference to Vietnam as well as Gebremedhin *et al.* (2017) in their study of small-ruminant production and marketing in Ethiopia.

Probability of market participation and intensity of participation are both significant and increasing with the possession of livestock. This shows that smallholder farmers with livestock are potentially more likely to increase their marketable surplus, participate in the markets and also intensify their participation. The intuition is that these farmers are more profit inclined and therefore prefer to maximise returns from this diversification and spread the risks associated with crop and animal production thinly across the two enterprises. Since smallholder farmers are risk averse, diversification is the best option to keep earnings constant in the face of risks (Wickramasinghe *et al*. 2014).

Probability of market participation is significant at the 1% level of significance and conditional on being a seller, the intensity of market participation is also significant at 1%, and expectedly, increasing in reference to access to and cultivation of improved cowpea seed. The results show that smallholder farmers who accessed and cultivated improved cowpea variety are 1% more likely to participate in the markets and also 1% more likely to sell their output in the market than households that did not access and cultivate improved cowpea variety. The result is consistent with

the findings of Tabe-Ojong & Mausch (2017). Accessibility of improved cowpea seed is crucial for increased market participation and intensity of participation among smallholder cowpea farmers in the Northern Region of Ghana.

Access to tractor services for ploughing was also found to be positively correlated with market participation but insignificant with the intensity of participation. The result indicates that conditional on smallholder being a cowpea producer, those who had access to tractor services for ploughing are 1% more likely to participate in the market than producers who had no access to tractor services. Access to tractor services for ploughing is an important factor in smallholder market participation decision making.

With regards to the district location variables, none was found to be significant in terms of cowpea production meaning there is no statistically significant difference between locations relative to Tolon. However, Kumbungu district was found to be significant at the 1% significance level in relation to market participation decision but was insignificant as far as the intensity of market participation was concerned. This finding shows that relative to Tolon, cowpea farmers in Kumbungu are more likely to participate in the markets. Tolon district however showed a decreasing relationship with the decision to participate in the market.

Furthermore, Tolon district was significant in terms of intensity of participation in the cowpea markets in the Northern Region. The implication therefore is that cowpea farmers in the Tolon district generate more marketable surpluses and therefore sell more proportion of their cowpea harvest relative to producers in Yendi, Mion and Kumbungu districts as also evident in the descriptive statistics. Additionally, these farmers might have benefited from pre-extension trials

and on-farm demonstrations and therefore are productive and produced more marketable surpluses than their counterparts from the other sampled districts in the Northern Region.

Test for multicollinearity, heteroskedasticity and endogeneity in the IV regression

The instrumental variable regression model was also checked for possible presence of multicollinearity. The estimated VIF values were less than the critical value of 10 (Gujarati & Porter, 2009; Shiferaw *et al*. 2008), confirming that multicollinearity was not a problem. The productivity model was also tested for heteroskedasticity by using the Breusch–Pagan/Cook–Weisberg test. The result indicated no presence of heteroskedasticity, since the calculated χ^2 value of (1.45) was smaller than the tabulated χ^2 value (3.84) at the 5% significance level and one degree of freedom.

In estimating the effects of intensity of market participation on productivity, a test for endogeneity and instruments validity were also carried out to establish whether indeed intensity of market participation measured by the proportion of sales is truly endogenous in the productivity model. The test result for possible endogeneity of proportion of sales in the productivity model indicates that the Durbin (score) χ^2 (1) = 11.7937, p-value = 0.0006 and Wu-Hausman F (1,218) =11.2662, p-value = 0.0009 are both highly significant and therefore the null hypothesis that all the variables are exogenous is rejected, implying that proportion of sales is highly endogenous in the productivity model, therefore endogeneity needs to be controlled for in the productivity model.

Additionally, the first-stage regression F-statistic for joint significance of instruments is highly significant, F (2, 218) =144.88, p-value = 0.0000 and the Partial R-squared value (0.550 or 55%) is far greater than the critical nominal 5% Wald test values and therefore the null hypothesis that the instruments used for market participation (possession of own means of transportation and

proximity to good road network) are weak is also rejected. Therefore the instrumental variable regression approach is used to estimate the effects of intensity of market participation on productivity. The regression estimates are displayed in table 4.9.

4.3.3 The effect of intensity of market participation on productivity

The coefficient estimates of the 2SLS regression are presented in table 4.9. The results indicate that, proportion of harvest sold, instrumented by the intensity of market participation variables is a significant correlate of productivity while controlling for other exogenous variables. Statistically, an increase in the proportion of output sold by a kilogram per cedi of sales, causes productivity or the gross value of cowpea production per hectare to increase by approximately 72% while controlling for other significant exogenous variables. This finding is consistent with that of Rios *et al.* (2009) and Strasberg *et al.* (1999) who identified a positive relationship between productivity and intensity of market participation.

Age of the smallholder farmer was found to be significant but rather had a decreasing or negative effect on productivity. This could be explained by the fact that, proportion of older people in the sample who might not be innovation inclined unlike the younger producers are less productive. This supports the finding of Boughton *et al.* (2007) who estimated a negative coefficient for maize productivity in Mozambique. Other literatures that support a negative estimated coefficient for age are Siziba *et al.* (2011), Olwande & Mathenge (2012), Rios *et al.* (2009) and Reyes *et al.* (2012).

The educational attainment of the household head, measured as the number of years spent in school had a positive effect on productivity and statistically significant at 5%. This means that a higher level of education of the smallholder farmer is associated with a higher level of productivity. This observation is consistent with the findings of Makhura *et al.* (2001), Enete & Igbokwe (2009),

Randela *et al.* (2008), Southworth & Johnston (1967), Schultz (1945) and Ofori (1973) who argued that education will endow the household with better production and managerial skills which could lead to increased productivity and higher output.

Farm size had the expected significantly positive effect on cowpea productivity. The result indicates that the larger the farm size per capita, the more it allowed the smallholder farmer to raise their productivity level. This result is in line with Rios *et al.* (2009) who found that Tanzania and Vietnamese farmers with larger land per worker are more productive.

The value of livestock owned by a smallholder farmer was also found to have a significantly positive relationship with cowpea productivity and significant at 1%. This finding suggests that cowpea farmers with diversified agricultural productions are likely to raise their productivity levels in order to maximise income from the sale of cowpea or maximise output for consumption in the unlikely event that their livestock do not attract good market or when they are not ready for sale. The result was found to be consistent with the findings by Minten & Barrett (2008) and Rios *et al.* (2009) who found similar relationship between livestock owned and crop productivity in Madagascar and Vietnam respectively.

Access to improved cowpea variety was also found to have the expected sign and significant at the 5% level of significance. The result indicates that cowpea farmers who had access to cowpea variety for cultivation had approximately 40% higher level of productivity than farmers who had no access to improved cowpea variety for cultivation. The result was found to be consistent with Strasberg *et al.* (1999) who found similar relationship between hybrid seed cultivation per acre and food crop productivity in Kenya.

As expected, access to credit was also found to depict a positive relationship with productivity and significant at the 1% level of significance. This result indicates that for farmers who had access to credit, their productivity level is approximately 8% higher than those who had no access to credit for farming. This finding suggests that access to credit is pivotal in achieving higher productivity levels of cowpea in the Northern Region.

The prevailing district level selling price of cowpea grain was also found to possess the expected coefficient and significant at the 1% level of significance. The result indicates that for every cedi (GHS) increase in the selling price of cowpea harvest per kilogramme, farmers' level of productivity is expected to increase by approximately 8%.

With regard to the location of smallholder producers, the coefficient for the variable indicating a smallholder producer located in the Mion district is statistically significant and negatively related to cowpea productivity as compared to a smallholder located in the Tolon district (reference district) showing an approximately 63% lower level of productivity. Mion district is characterised by poor infrastructure with remote communities from a well-developed agricultural research station unlike Tolon where the Savannah Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR) is located.

Similarly, Kumbungu district also had a statistically significant relationship with productivity with cowpea producers in that district having about 86% level of productivity relative to Tolon. This maybe due to the fact that it is relatively a new district with inadequate infrastructure that directly contributes to and promotes productivity.

Table 4.9: Instrumental Variable Regression Estimates of Productivity with Endogenous Intensity of Participation

Variable	Coefficient	t-Statistics
Intensity of Participation		
Proportion of sales	0.717**	2.49
	(0.875)	
Household Characteristics		
Age	-0.006*	-1.78
	(0.005)	
Gender	-0.061	-0.30
	(0.200)	
Dependency ratio	0.008	0.67
	(0.011)	
Education	0.006**	2.52
	(0.012)	
Farm size	0.407**	1.94
	0.210)	
Transaction Cost Variables		
Distance to market	0.009	0.64
	(0.014)	
Access to market information	0.118	0.63
	(0.187)	
Resource Endowments/Institutional Factors		
Total household income	-0.183	-0.92
	(0.199)	
Labour	-0.013	-1.06
	(0.012)	
Value of livestock owned	0.001***	3.92
	(0.000)	
Access to improved cowpea seed	0.407**	1.95
	(0.210)	
Access to tractor services for ploughing	0.037	0.28
	(0.132)	
Access to credit	0.078***	2.95
	(0.026)	
Access to extension services	0.010	0.08
	(0.119)	
Market Price Variable		
Selling price of cowpea	0.078**	2.95
	(0.026)	
Location Variables		
Tolon district	Reference	
Yendi district	-0.493	-1.16
	(0.423)	

Table 4.9: Instrumental Variable Regression Estimates of Productivity with Endogenous Intensity of Participation cont'd

Variable	Coefficient	t-Statistics
Kumbungu district	-0.857***	-2.94
	(0.292)	
Constant	3.745***	4.36
	(0.859)	
Breusch-Pagan / Cook-Weisberg test for heteroscedasticity		
χ^2 (1) = 0.12		
Prob > χ^2 = 0.7250		

Source: Computation from Household Survey, 2018.
Notes: Robust standard error in parentheses. *, ** and *** represent significance at 10%, 5%, and 1% level, respectively. Dependent variable is the natural log of gross value of output produced per hectare.

Factors influencing cowpea production decision include: age, gender, dependency ratio, distance to nearest market, own means of transportation, proximity to good road network, labour, access to own land, access to improved cowpea seed, access to tractor for ploughing and extension services.

Factors influencing smallholder farmers' decision to participate in the market include: age, distance to nearest market, own means of transportation, access to market information, total volume of output produced, livestock owned, access to and cultivation of improved cowpea seed and the district location dummies Kumbungu and Tolon. Determinants of intensity of participation in the output markets include: age, education, own means of transportation, proximity to an all-weather good road network, off-farm income, livestock owned, access to and cultivation of improved cowpea variety, and the district location dummy Tolon.

Overall determinants of cowpea production, market participation and intensity of market participation include: age, gender, farm size, dependency ratio, education, distance to nearest market, access to market information and ownership of own means of transportation. Other factors include proximity to all- weather good road network, total output from cowpea production, off-

farm income, labour, access to own land, value of livestock owned and access to and cultivation of improved cowpea variety. Also, access to tractor services for ploughing, extension services, and district location dummies Tolon and Kumbungu were the other determinants.

Determinants of cowpea productivity include: proportion of sales, age, education, farm size, livestock owned, access to and cultivation of improved cowpea seed, credit and selling price of cowpea. District location dummies such as Tolon, Mion and Kumbungu also influenced cowpea productivity.

From the stated hypotheses, it can be concluded that transaction cost variables notably distance to market, own means of transportation, proximity to good road network as well as access to market information separately influence cowpea production and market participation decisions. Intensity of market participation also positively affect productivity and therefore the hypothesis that intensity of market participation has a positive relationship with cowpea productivity can be supported.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the major findings, the conclusions and the recommendations emanating from the conclusions of the study. Suggestions for future research are also presented.

5.2 Summary of the Study

The study analyses the factors influencing cowpea production and market participation decisions of smallholder farmers whiles also establishing the extent to which intensity of market participation affects productivity. The estimations were carried out descriptively and analytically. The Triple Hurdle Model (THM) which comprised of the first and second hurdles being Probit models and the third hurdle a Truncated normal regression model, was used to identify the factors influencing smallholder farmers' decision to produce cowpea, participate in the market and the intensity of participation. The simultaneous estimation procedure via the maximum likelihood estimation accounts for endogeneity bias in the study. The instrumental variable regression model was used to analyse the effect of intensity of market participation on productivity of smallholder cowpea producers. The appropriate estimation tests were performed to ensure that the assumptions underlying the instrumental variable regression using the Two-Stage Least Squares estimator employed for the analysis are satisfied. The empirical results confirm the endogeneity of intensity of market participation and was therefore instrumented.

The findings based on the descriptive analyses indicated that the regional aggregate gross value of cowpea from the study was found to be 224,164.80 Ghana Cedis per hectare per production season.

The aggregate market participation of smallholder cowpea producing households revealed an average marketed surplus ratio of 53%.

The factors influencing smallholder producers' decision to participate in cowpea production include: age of the household head, gender of the household head, dependency ratio, distance to nearest market, own means of transportation, proximity to good road network, labour, possession of own land for farming, access to improved cowpea seed, access to tractor services for ploughing and the provision of extension services.

The factors identified to influence smallholder farmers' decision to participate in the market are age of the household head, distance to nearest market, own means of transportation, access to market information, total volume of output produced, value of livestock owned, access to and cultivation of improved cowpea seed, access to tractor services and the district location dummies Kumbungu and Tolon.

Determinants of the intensity of participation in the cowpea market was found to include age of the household head, education, own means of transportation, proximity to an all-weather good road network, off-farm income, value of livestock owned, access to and cultivation of improved cowpea variety, and the district location dummy Tolon.

Determinants of cowpea productivity also include the intensity of market participation measured as the proportion of output sold hence the need to control for endogeneity. This finding means that the more smallholder farmers participate in the markets, the higher their level of productivity. Other determinants of cowpea productivity include: age, education, farm size, livestock owned,

access to and cultivation of improved cowpea variety, credit, selling price of cowpea and district location dummies Tolon, Mion and Kumbungu.

5.3 Conclusions of the Study

Based on the above findings, the following conclusions are made. A strong argument can be advanced that cowpea is gradually becoming a cash crop and not just a staple in the Northern Region of Ghana since 53% of the total cowpea output is sold by smallholder farmers for income. Smallholder farmers are encouraged to participate in cowpea production when distance to both inputs and outputs markets are reduced and there is good road network linking communities to facilitate mobility to and from the markets. Possession of own means of transportation and own land for farming purposes also facilitate cowpea production. Farmers are also likely to participate in cowpea production when they have easy access to improved seed, tractor and extensions services.

The study also found out that smallholder farmers are likely to participate in the market conditional on their production if transaction costs in participating in the market place are low as a result of shorter distance to markets and access to market information. Additionally, smallholder farmers with own means of transportation are likely to participate in the market because it leads to the reduction in the marginal cost of movement. The findings also showed that value of livestock owned, access to and cultivation of improved cowpea seed as well as tractor services stimulate participation in the market.

The findings also revealed that conditional on participating in the market as a seller, smallholder cowpea producers will intensify their participation when they are well educated either formally or informally to enable them understand prevailing market dynamics. Also, ownership of means of

transportation, proximity to an all-weather good road network linking communities to marketing centres will encourage them to intensify their market participation activities. Finally, involvement in off-farm income generating activities, value of livestock owned and access to improved and high yielding cowpea seed varieties which are drought, disease and pest resistant for cultivation and readily available will encourage smallholder producers to intensify participation in the cowpea market.

Smallholder cowpea producers' intensity of market participation positively affects their level of productivity. Therefore, the more smallholder farmers participate in the markets, the higher their level of productivity. Other key determinants of cowpea productivity include educational level of the household head, farm size cultivated, value of livestock owned and access to and cultivation of improved cowpea seed. Other significant exogenous variables that influence productivity of cowpea include educational level of the smallholder farmer, farm size cultivated, value of livestock owned and access to and cultivation of improved cowpea seed. Formulation of policies to ensure lower transaction costs among smallholder farmers will intensify their market participation activities and hence accelerate poverty reduction among smallholder cowpea producers in the Northern Region of Ghana.

5.4 Recommendations of the Study

Based on the conclusions of the study, the following recommendations are propounded. Formulation of policies to increase production, productivity and market participation in order to accelerate the promotion of pro-poor growth among smallholder cowpea producers and non-producers in the Northern Region of Ghana since a significant proportion of cowpea produced in the region is sold for income. Productivity promoting policies should be designed to encompass

formal educational training to enable smallholder cowpea producers understand and appreciate how market functions.

Policy measures that ensure and promote agricultural diversification and easy access to inputs should be put in place by the Ministry of Food and Agriculture. The ministry to also include cowpea as one of the priority food crops under the flagship "Planting For Food and Jobs programme" while the cowpea farmer field schools programme be intensified to assist farmers produce more marketable surplus to induce non-cowpea producers to also start producing. The ministry to also liaise with the private sector to ensure that provision of tractor hiring services are readily made available to smallholder cowpea producers. The Ministry of Education should engage with non-governmental and Farmer Based Organisations in the Northern Region to develop and promote the "cowpea farmer business schools" concept to offer relevant skills and knowledge to farmers. This is also likely to induce non-cowpea producers to start producing.

International and local scientific research institutions such as the International Institute of Tropical Agriculture (IITA), Council for Scientific and Industrial Research (CSIR) and West African Centre for Crop Improvement (WACCI) to develop and disseminate more improved cowpea varieties in the Northern Region in particular and the country as a whole. The Central government should intervene in facilitating farmers-to-markets linkage by developing adequate physical infrastructure to support market connectivity and extension services.

The Ministry of Trade and Industry, and the local municipal and district assemblies to facilitate the construction of modern markets in the major cowpea producing communities to ensure market access in the Northern Region. The Road Transport Ministry and its subsidiary institutions such as urban and feeder roads to build and maintain existing road networks to facilitate cowpea

production and marketing in the Northern Region. Though public investment in the provision of public goods is essential, it is not sufficient to enable smallholder farmers enter markets. Smallholder farmers therefore need to invest to acquire their own land and own means of transportation in order to fully benefit from public infrastructure to sustain their cowpea production ventures in particular and other crop farming operations in general.

5.5 Suggestions for Future Research

It is suggested for a future research to be undertaken that considers all the three distinct categories of market participation namely, net sellers (households with positive net sales), autarkic (households with zero net sales or households who produce purposely for household consumption) and net buyers (households with negative net sales) in order to provide a more detailed dimension of market participation. This suggested study should however be undertaken using a panel or survey data in order to obtain a very large sample size for a national generalisation to be done.

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APPENDICES

Appendix 3.1: Questionnaire for Household Survey

This questionnaire is to solicit information on the thesis title: **Production, Productivity and Market Participation of Smallholder Cowpea Producers in the Northern Region of Ghana**.

All information provided will be treated as confidential and will be used solely for the purpose of the study.

Interviewer_____ Date of interview _____/_____/2018

Location (District Name) _____ Population of District _____

Community/Village_____ Questionnaire Number _____

Farmer: Cowpea Producer [ ] Non-producer [ ]

Section A: Household Demographic and Socioeconomic Characteristics

Responses to be provided by the household decision maker

Farmer Characteristics				
Name of respondent	**Age**	**Gender**	**Household Size**	**Tel. No**
Dependency ratio: No. of persons (children 0-15 years and adults above 64years)_____				
No. of persons (16-64 years of age) _____				
What is your level of education? _____				
Years spent to reach current level of education? _____				
Number of people chronically ill in the past month _____				

1. How many years have you spent farming cowpea? _____
2. Indicate your source of labour? 01 = Own labour [ ] 02 = Family labour [ ]

3. 03 = Hired labour [ ] 04 = Others [ ] please specify _____
4. Are you a member of any farmer based organisation? 01 = Yes [ ] 02 = No [ ] **(If No move to Q6)**
5. If yes, give the name of the FBO _____
6. How often does the association meet to discuss issues related to cowpea production? 01= Weekly [ ] 02 = Fortnightly [ ] 03 = Monthly [ ] 04 = Quarterly [ ] 05 = Annually [ ]
7. If No, why _____
8. Please kindly indicate your ethnicity _____
9. What is your religion? 01 = Christian [ ] 02 = Islam [ ] 03 = Traditional [ ] 04 = Others [ ], specify _____

10. **Farm Size**

Amount of land size devoted to cowpea production in acres _____

Do you own the land devoted to cowpea production? 01 = Yes [ ] 02 = No [ ]

If no, how do you pay for it? 01 = Cash [ ] 02 = Produce [ ] 03 = Others [ ], specify _____

What is the land ownership type? 01 = Own land [ ] 02 = Family land [ ] 03 = Hired land [ ] 04 = Others [ ], specify _____

Do you intercrop cowpea with other crops? 01 = Yes [ ] 02 = No [ ]

If yes, which crops do intercrop with cowpea? _____

Non-Cowpea Income

Do you engage in other crop farming apart from cowpea? 01 = Yes [ ] 02 = No [ ]

(If no move Q.10)

If yes, indicate the crops

_____

If you engaged in other crop farming activities for income indicate below

No.	Tick	Source of Farm Income Activity	Amount (GHS)
1		Food Crops: e.g cassava, maize, millet, yam, sorghum, groundnut, rice, tomato, pepper etc.	
2		Cash crops: e.g soybeans, cotton, tobacco etc.	

3		Livestock: e.g goat, sheep, cattle, chicken, turkey, etc	
4		Farm wages: e.g labour in other farms etc.	
Total Amount (GHS)			

11. **Non-farm Income**

Did you engage in any non-farm income activity in the 2017 season?

01 = Yes [ ] 02 = No [ ]

11. If yes, what are the sources of your non-farm income? Indicate below

No.	**Tick**	**Source of non-farm income Activity**	**Amount (GHS)**
1		Non-farm wage income e.g security etc	
2		Self-employed income e.g trading, artisan, carpentry, etc	
3		Others e.g pension capital earnings etc	
Total Amount (GHS)			

12. Did you receive remittance in 2017? 01 = Yes [ ] 02 = No [ ]

13. If yes, indicate the total amount received _____

Section B: Market and Marketing Characteristics (selling) Information

Production

14. What was the total quantity of cowpea harvested (Kg/bags) in the 2017 growing season?

15. Did you have access to tractor in ploughing your field?

01 = Yes [ ] 02 = No [ ]

16. Did you have access to improved cowpea variety in the 2017 season?

01 = Yes [ ] 02 = No [ ]

(if no move to Q18)

17. If yes, what was the source of the variety? 01 = MoFA [ ] 02 = SARI [ ]

03 = NGOs [ ] Others [ ] specify _____

18. Did you apply fertiliser in your farming operation in the 2017 season? 01 = Yes [ ]

02 = No [ ]

19. How many working days did you spend on cowpea production during the production season? _____

Market Characteristics

20. What is the distance in miles to the nearest market? _____

21. Is the nature of the road good? 01 = Yes [ ] 02 = No [ ]

22. Do you have your own means of transportation to the marketing centre? 01 = Yes [ ] 02 = No [ ]

23. If yes, which of the following is applicable? 01 = Bicycle [ ] 02 = Motorbike/Motor King

[ ] 03 = Vehicle [ ] 04 = Donkey [ ] 05 = Others [ ] specify _____

24. Did you sell cowpea during the 2017 production season? 01 = Yes [ ] 02 = No [ ]

25. If yes, what was the price of a bag/bowl of cowpea? _____

26. Indicate the quantity of cowpea produced, bought or sold in the table below

Cowpea produced in bags/kg	**Cowpea bought in bags/kg**	**Cowpea sold in bags/kg**

27. In reference to Q**23**, why did you not sell your produce? 01 = Purposely for eating [ ] 02 = Price was not good [ ] 03 = Could not access market [ ] 04 = Others [ ] specify _____

28. Where was your point of sale? 01 = Market [ ] 02 = House [ ] Others [ ] specify ___

29. Did you access market information regarding the price of cowpea? 01 = Yes [ ] 02 = No [ ]

Section C: Resource Endowments (Environment and Institutional Characteristics)

Public, Private assets and Services
30. Did you have access to credit for your farm operations in the 2017 season?
01 = Yes [ ] 02 = No [ ]
(If no move to Q.34)
31. If yes, what was the form of the credit? 01 = Agricultural inputs 02 = Cash [ ]
03 = Both [ ]
32. If agricultural inputs, did you receive the inputs? 01 = Yes [ ] 02 = No [ ]
33. Kindly indicate the source of your credit. 01 = Neighbours/Relatives/Friends [ ] 02 =
Banks/Microfinance Institutions [ ] 03 = NGOs [ ] 04 = Others [ ] specify _____
34. Did you irrigate you farm during the 2017 season? 01 = Yes [ ] 02 = No [ ]
(if no move to Q36)
35. If yes, indicate the type of irrigation practised. 01 = Surface [ ] 02 = Drip [ ] 03 =
Sprinkler [ ] 04 Others [ ] specify _____
36. Did you receive extension contacts during the 2017 season? 01 = Yes [ ] 02 = No [ ]
37. Did you have a mobile phone in the 2017 season? 1 = Yes [ ] 02 = No [ ]
(if no move to Q39)
38. If yes, did you use it to access market information? 01 = Yes [ ] 02 = No [ ]
39. Do you have a storage facility for storing cowpea? 01 = Yes [ ] 02 = No [ ]
40. Did you own a radio during the 2017 farming season? 01 = Yes [ ] 02 = No [ ]