

**UNIVERSITY OF GHANA**

**COLLEGE OF BASIC AND APPLIED SCIENCES**

**AGRICULTURAL COMMERCIALISATION AND FOOD CROP PRODUCTIVITY  
AS PATHWAYS TO POVERTY REDUCTION AMONG SMALLHOLDER  
FARMERS IN RURAL BURKINA FASO**

**BY**

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**(10500371)**

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## DECLARATION

This thesis is the result of research work undertaken by Sugrinoma Aristide Ouédraogo in the Department of Agricultural Economics & Agribusiness, University of Ghana, under the supervision of Professor Ramatu Mahama Al-Hassan, Professor Daniel Bruce Sarpong, Mr. D. P. K. Amegashie and Professor Pam Zahonogo. It has never been submitted in whole or in part for any degree in this University or elsewhere. References to other people's work have been duly acknowledged.

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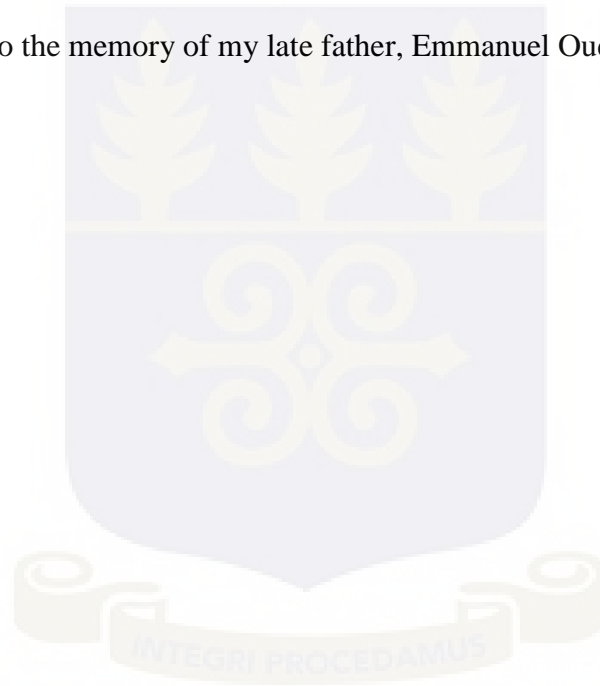
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## ABSTRACT

Despite the growing interest to promote agricultural commercialisation in Burkina Faso, the majority of smallholders are still mainly subsistence-oriented with generally low level of market supply. However, evidence on the key factors that influence agricultural commercialisation and the extent to which it affects rural poverty is still scanty. This study therefore analyses the determinants of smallholders' market supply and the implications of agricultural commercialisation and food crop productivity for poverty reduction in rural Burkina Faso. The research uses survey data collected from 1,178 farm households in 270 villages selected across the country. The assessment of the level of agricultural commercialisation (or intensity of market participation) using crop commercialisation index shows a low level of market participation of smallholder farmers. Indeed, the intensity of crop commercialisation for the whole sample is estimated at 17% of crop harvested. Among the 56% of the households that present a positive amount of crop sold, the proportion of sales is estimated at 30%. However, there is a high heterogeneity in the intensity of households' crop commercialisation on the basis of land endowment, gender of the household head and across regions due to difference in the agro-climatic conditions. The double hurdle model is first used to analyse the factors affecting decisions of farm households to participate in crop markets, and the intensity of crop supply. The findings show that households' access to productive resources such as farm size per worker, use of animal traction, the quantity of fertiliser used per hectare and access to credit, significantly increase the likelihood of households' market participation and the intensity of crop commercialisation. Furthermore, indicators of transaction costs such as ownership of communication equipment and quality of rural roads present a significant effect on the likelihood of smallholders' market participation but not on the intensity of crop sale, once participation decision is made. However, the estimates of Average Partial Effects (APEs) suggest that, in addition to access to productive resources, the overall intensity of crop supply is significantly determined by ownership of communication assets and quality of rural roads. Thus, both access to productive resources and level of transaction costs determine the intensity of smallholders' crop supply. Secondly, the effect of smallholders' agricultural commercialisation on input use and food crop productivity is analysed. Estimating a Tobit model, the results indicate a positive and significant effect of intensity of households' market participation on fertiliser use per hectare. In addition, the effect of commercialisation on food crop productivity is estimated, using the method of instrumental variables to solve the problem of endogeneity of crop commercialisation index. The findings show that the effect of agricultural commercialisation on food crop productivity is positive and statistically significant. Thirdly, the study estimates a Logit regression model to analyse the effect of crop commercialisation on poverty among smallholder farmers and the influence of food crop yield in this relationship. Thus, the model includes an interaction term between crop commercialisation index and food crop yield. The results show that, at low yield of food crops, commercialisation can result in welfare loss and increase in the likelihood of being poor; while with a high level of yield, the intensity of crop supply becomes a crucial factor of poverty reduction. These findings establish agricultural commercialisation and productivity growth as pathways to poverty reduction in Burkina Faso. Therefore, promotion of agricultural commercialisation is crucial to stimulate technological change in agricultural sector, and ultimately to alleviate rural poverty in Burkina Faso. However, this would require public investments to improve rural accessibility and facilitate smallholders' access to productive resources. In addition, to enhance the contribution of agricultural commercialisation to poverty reduction, policy should also be designed to improve yield of food crops.

## DEDICATION

To the memory of my late father, Emmanuel Ouédraogo



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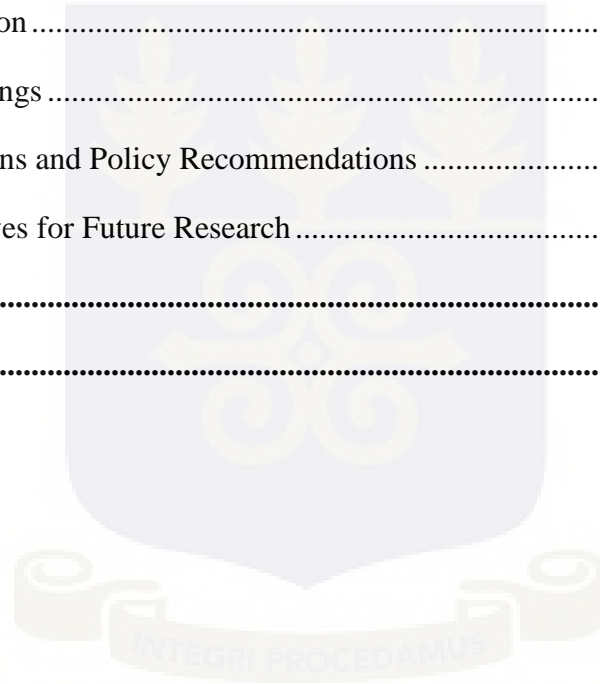
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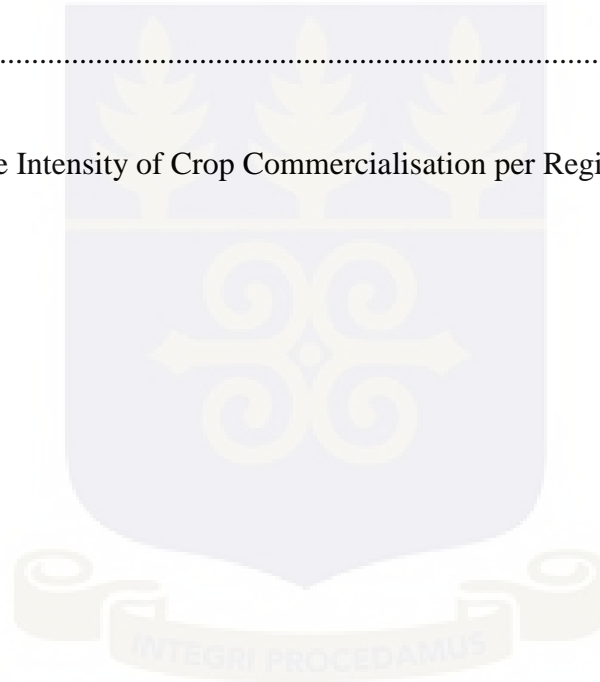


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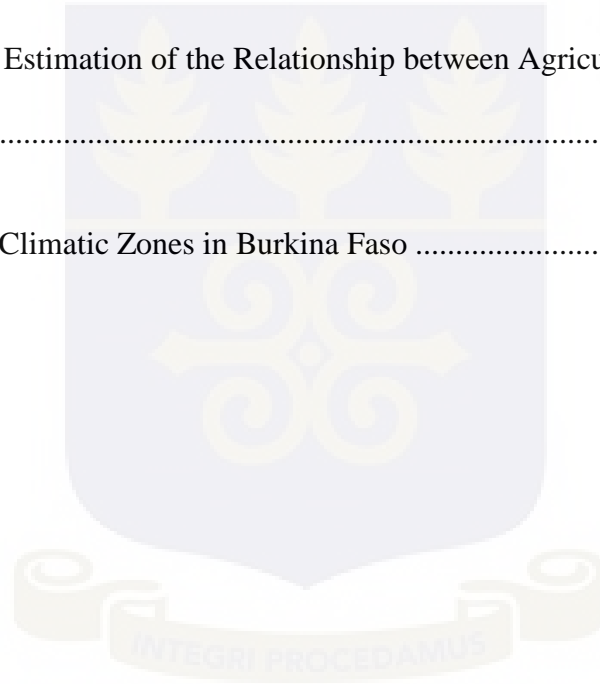
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## LIST OF ABBREVIATIONS AND ACRONYMS

<b>AGRA</b>	Alliance for Green Revolution in Africa
<b>APE</b>	Average Partial Effect
<b>CAADP</b>	Comprehensive African Agricultural Development Programme
<b>CCI</b>	Household Crop Commercialisation Index
<b>CSI</b>	Crop Specific Commercialisation Index
<b>DHM</b>	Double Hurdle Model
<b>FAO</b>	Food and Agriculture Organization
<b>FCFA</b>	Francs de la Communauté Financière d’Afrique
<b>FGT</b>	Foster-Greer-Thorbecke
<b>FIDA</b>	Fonds International pour le Développement Agricole
<b>FMI</b>	Fonds Monétaire International
<b>FTC</b>	Fixed Transaction Cost
<b>GDP</b>	Gross Domestic Product
<b>IFAD</b>	International Fund for Agricultural Development
<b>IITA</b>	International Institute of Tropical Agriculture
<b>IMF</b>	International Monetary Fund
<b>IMR</b>	Inverse of Mills Ratio
<b>INSD</b>	Institut National de la Statistique et de la Démographie
<b>IV</b>	Instrumental Variable
<b>LAQAD-S</b>	Laboratoire d’Analyse Quantitative Appliqué au Développement-Sahel
<b>LSMS</b>	Living Standard Measurement Survey
<b>MEF</b>	Ministry of Economy and Finance
<b>MDG</b>	Millennium Development Goals
<b>MIS</b>	Market Information Service
<b>MRP</b>	Mix Recall Periods
<b>NEPAD</b>	New Partnership for Africa’s Development
<b>NIE</b>	New Institutional Economics
<b>NPTC</b>	Non-Proportional Transaction Cost
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>OFNACER</b>	Office National des Céréales
<b>OLS</b>	Ordinary Least Square
<b>PNGT</b>	Programme National de Gestion des Terroirs
<b>PTC</b>	Proportional Transaction Costs
<b>SAP</b>	Structural Adjustment Program
<b>SOFITEX</b>	Société des Fibres Textiles
<b>SSA</b>	Sub-Saharan Africa
<b>TLU</b>	Tropical Livestock Unit
<b>WB</b>	World Bank

## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Background**

##### **1.1.1 Importance of Promoting Agricultural Commercialisation among Smallholder Farmers in Developing Countries**

Of the world's 1.2 billion extremely poor people, 75 percent live in rural areas and mostly depend on agriculture for their livelihood (Anríquez & Stamoulis, 2007). Particularly in Sub-Saharan Africa (SSA), agriculture represents the main source of income and food for a huge majority of rural poor. However, growth in farm productivity in Africa compared to other developing countries has been slow, resulting in low decline in poverty incidence among subsistence smallholder farmers. This has reinforced the views of several authors that promoting agricultural commercialisation among smallholder farmers represents a promising strategy to improve agriculture's contribution to poverty reduction and economic growth. For instance, World Bank (2008) emphasises the importance of investing in agriculture particularly among smallholder farmers for sustained and global poverty reduction in agricultural-based countries. De Janvry & Sadoulet (2009) argue that the effect of agricultural growth on rural poverty reduction will depend on the degree of smallholder farmers' integration into markets.

However, despite various policy reforms aimed at increasing farmers' integration into markets, the majority of smallholder farmers in Africa are still subsistence-oriented with low level of participation in agricultural markets, and those who do, generally sell small

quantities. In fact, Jayne, Mather, & Mghenyi (2010) estimate at about 20 to 35% the proportion of smallholders that sell crops in a given year in Sub-Saharan Africa and find out a high concentration of marketed agricultural surplus among a small number of farm households that have relatively large land size.

This low supply response of farm households to policy incentives is frequently related to high level of transaction costs in agricultural sector (Alene *et al.*, 2008; Barrett, 2008; De Janvry & Sadoulet, 1993; Goetz, 1992; Henning & Henningsen, 2007; Key, Sadoulet, & De Janvry, 2000; Omamo, 1998a). Assumed to be household-specific, transaction costs result in heterogeneous market participation of farm households, characterised by a coexistence of subsistence and commercial farmers in rural areas (De Janvry, Fafchamps, & Sadoulet, 1991). In some cases, constraints in production capabilities limit households' ability to produce marketable surplus. This means that differences in access to productive resources (land, input, labour, equipment) may also explain the differences in the ability of farm households to participate in markets. Another factor raised in the literature that explains farm households' market participation is related to market risk which is reinforced when markets are weakly spatially integrated (Dawe & Peter Timmer, 2012; Shively & Thapa, 2016). The importance of each factor in explaining farm households' participation in agricultural commercialisation may differ across households and countries, requiring in each case, a deep investigation into the drivers of smallholder farmers' marketing behaviour.

In addition, the welfare gained through agricultural commercialisation is neither static nor universally granted. In the short run, by exploiting comparative advantage, farmers can raise their income and food security status through integration in commercial farming. In the long

run, through specialisation and dynamic technological change, agricultural commercialisation would improve farm productivity and welfare of households (Barrett, 2008). The benefit of commercialisation can also be extended to rural labour suppliers and food buyers through higher wage rate and lower food prices due to technological change. Furthermore, increased specialisation at household and regional levels due to agricultural commercialisation may be consistent with increased diversification of agricultural output produced at national level leading to improvement in the welfare of rural households (Pingali & Rosegrant, 1995; Timmer, 1997). Therefore, agricultural commercialisation is viewed as inherent to the development process if the sector has to actively contribute to growth and poverty reduction (Pingali & Rosegrant, 1995).

Yet, some scepticism remains about the positive welfare effect of agricultural commercialisation for smallholder farmers. For instance, it is often argued that exploiting the comparative advantage may be costly for farmers while the benefit of commercialisation is unstable (Cadot, Dutoit, & Olarreaga, 2006). Furthermore, early studies claimed that declining terms of trade may dissipate the short run positive effect as far as export crops are concerned while policy bias such as over-valuation of exchange rate and unequal exchange may extract the surplus from rural to urban areas (Maxwell & Fernando, 1989)<sup>1</sup>. Von Braun (1995) sustains that this possible perverse effect can emerge in the context of failures of institutions, policies, or markets which by increasing transaction costs may reduce the profitability of agricultural commercialisation for smallholders. In addition, when intra-

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<sup>1</sup> Maxwell & Fernando (1989) presents a summary of the early debate on the relationship between agricultural commercialisation and rural households' welfare.

household factors distort households' resource allocation at the expense of food expenditure, the income gained through commercialisation may not lead to improvement in farm households' food security.

Some recent empirical studies have emphasised the negative effects of agricultural commercialisation on households' wellbeing. Thus, Wood, Nelson, Kilic, & Murray (2013) found a negative effect of adoption of non-food cash crop production on child nutrition status in context of food price shocks in Malawi. Muriithi & Matz (2015) in Kenya and Carletto, Corral, & Guelfi (2017) in a study on three African countries (Malawi, Tanzania, Uganda) found that income growth through increased commercialisation of crops did not result in improvement in households' food security and asset accumulation.

Therefore, the findings on the relationship between agricultural commercialisation and rural households' welfare in existing literature are not conclusive. In addition, due to the difference in structural conditions of countries, and in the potentialities of their agricultural sectors, empirical findings cannot be generalised without caution. Furthermore, Von Braun (1995) notes that the dichotomous definition in the early studies of commercial and non-commercial farmers based on a mere distinction of adoption and non-adoption of cash crops was too restrictive to analyse the extent of agricultural commercialisation and its implications on the wellbeing of farm households. This restrictive view omits food crop production and commercialisation in which the huge majority of smallholder farm households are mainly involved and thus, may misguide agricultural policy that aimed at promoting farm households' market integration. This led Von Braun (1995) to consider agricultural commercialisation in a broader sense as a structural transformation of agricultural sector

which does not necessarily require a shift from food crops to non-food cash crop production but can also occur within the traditional food crop farming.

However, in semi-arid countries such as Burkina Faso, the literature in agricultural commercialisation is still scanty. The existing studies generally exclusively focus on so-called cash crop sector, namely cotton. Therefore, this thesis will contribute to the existing literature in seeking to understand the key determinants of smallholder farmers' marketing behaviour and the extent to which agricultural commercialisation and food crop productivity affect rural households' wellbeing in Burkina Faso. In order to avoid a crude and subjective distinction between cash and food crop producers, this study considers household level of commercialisation in terms of the intensity of agricultural output traded.

### **1.1.2 Agriculture and Policy Reforms in Burkina Faso: Some Stylised Facts**

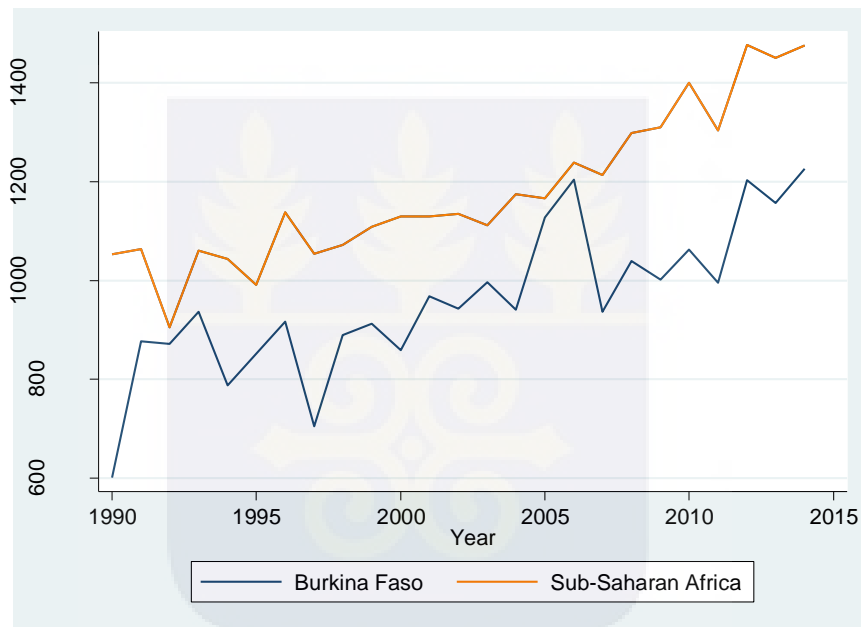
#### **1.1.2.1 Agricultural Productivity and Rural Poverty in Burkina Faso**

Agriculture is fundamental in the livelihood of rural households in Burkina Faso and represents a key sector that can strongly stimulate a pro-poor economic growth. The sector represents about 35% of GDP and employs over 70% of economically active population. Mainly rain fed agriculture, the production is highly dependent on climatic conditions. Cereal staple crops, namely sorghum, millet and maize represent the dominant crops produced in the country and occupy on average, about 65 percent of arable lands (INSD, 2016). The average annual growth of cereal production was about 3% between 2001 and 2010 led by maize which experienced a steady growth of 10.17% on average annually. Sorghum and millet, on the other hand, experienced the lowest performance with an average growth of

1.63% (INSD, 2016). Cotton represents the major crops produced for market but occupies only 11 percent of cultivated lands.

As illustrated by the Figure 1.1, cereal yield in Burkina Faso has been very low and characterised by high volatility compared to average yield of cereal in Sub Sahara Africa<sup>2</sup>.

**Figure 1.1: Trend of Cereal Yield (kg/ha) in Burkina Faso and Sub-Saharan Africa, 1990-2015**



Source: Author, Based on FAO dataset (available at <http://fao.org/faostat/en/#data>)

Production growth has been more related to land expansion than to productivity gains. Thus, on average, farm households in Burkina Faso use 10 kg/ha of fertiliser, which is lower than

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<sup>2</sup> Cereal yield computed by FAO is measured as kilograms per hectare of harvested land and includes wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Production data on cereals relate to crops harvested for dry grain only. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded. The FAO allocates production data to the calendar year in which the bulk of the harvest took place. Most of a crop harvested near the end of a year will be used in the following year (<http://fao.org/faostat/en/#data>, last date of access: 20/12//2017).

the average 15-20 kg/ha used in SSA and 70–150 kg/ha in the Caribbean and South-East Asian countries (FAO database). However, as regards to soil degradation, population pressure and increase in opportunity costs of labour, production growth based on land expansion is becoming a less sustainable option and adoption of productivity enhancing technology is required to increase household production level and market surplus.

This low productivity is certainly central in the persistence of rural poverty which declined at a lower rate compared to the pattern of national poverty incidence. In fact, from 51.1% in 2003, the national poverty rate declined to 46.7% in 2009 and to 40.1% in 2014, representing a reduction of roughly 10 points from 2003 to 2014 (INSD, 2016). In rural areas where over 90% of the nation's poor population reside, the magnitude of poverty reduction in the same period was only by 5 percentage points. In fact, according to INSD (2016), rural poverty in Burkina Faso declined from 52.3% to 47.5% between 2003 and 2014.

#### **1.1.2.2 Food and Agricultural Policy Reforms and Constraints of Smallholders' Market Integration**

The evolution of agricultural policies in Burkina Faso has followed a similar path like in most of Sub-Saharan African countries where state-led development policies, characterised by price controls was replaced by market-led policies during the 1990s. Before, the implementation of the Structural Adjustment Programmes (SAP), and until late 1980s, food and agricultural policies were characterised by a strong public intervention in price administration in order to prevent welfare loss due to price fluctuation and to improve availability and accessibility of food by consumers. In the 1990s, policy reforms were undertaken by governments under the aegis of international institutions (World Bank and

International Monetary Fund) in order to improve economic performance of the agricultural sector through market development. This gave rise to liberalisation of agricultural commercialisation and suppression of controls on cereal prices. The importance of promoting agricultural commercialisation and food crop production growth for effective rural poverty reduction has particularly gained renewed attention during the international food crisis in 2008. However, to offset the welfare lost by consumers, the Government of Burkina Faso (Go.BF) reinitiated some price support measures through tax exemptions on food imports, and food supply at social price.

In the case of the cotton sector, some policy reforms were undertaken in the mid-1990s. Before the reforms, like in the case of cereal crops, the production and commercialisation of cotton were managed by a parastatal company namely SOFITEX (*“Société des Fibres Textiles”*) that operated as a monopoly. The relationship of SOFITEX with cotton farmers stands as a contract farming in which the former provides seed, fertiliser, loan, marketing and extension services against an exclusive right to purchase the cotton output. Kazianga & Makamu (2016) focusing on cotton production expansion policy in Burkina Faso, highlight two stages in the process of policy reform in cotton sector. The first stage which aimed at reducing the low credit repayment rate of farmers, allowed the establishment of farmer organisations based on voluntary participation, contrary to farmer association that were formed on the basis of farmers’ residency in a given village.

The second phase of the reform undertaken after the devaluation of FCFA in early 1994 allowed new companies to supply similar services offered by SOFITEX in other localities, namely in the Central and Eastern provinces, where SOFITEX was not operating previously.

For Kazianga & Makamu (2016), these reforms, combined with the devaluation of the currency, contributed to rendering cotton cultivation a profitable business in the Central, Eastern, and South-Eastern regions where commercial farming of cotton crop was not developed before the policy reforms. The reforms also contributed to rapid growth of the sector and permitted the country to stand as one of a leader in cotton growing and exportation among African countries. Until the explosion of mining in 2010, cotton represented 50% to 60% of the country's foreign earnings and employed roughly two million people. Though the proportion of cotton in export is now estimated at about 18%, the sector continues to represent an important part in the livelihood of many rural population (FMI, 2014). At household level, it is often argued that cotton production improved farmers' access to inputs and services and this has contributed to increase in cereal crop productivity and reinforced the link between agricultural commercialisation, food productivity and rural income.

However, there are numerous challenges faced by policymakers in promoting farm households' participation in agricultural output markets in Burkina Faso. Like in many African countries, it is often argued that policy reforms promoting export crop production did not provide substantial benefit to poor farm households. Birner & Resnick (2010) note that in many cases, the overall agricultural response was much lower than other sectors and export crops have benefitted more from trade and markets than food crops. The result has been a worsening of income disparity in rural areas because households in most favoured areas with better access to markets benefitted more than the rural landless and poor who are mainly food crop producers. In addition, it is argued that, in many countries, services such as input and extension supply and credit support have disappeared due to reforms undertaken under SAP (Alene *et al.*, 2008). Consequently, despite the market liberalisation under the

SAP, the majority of farm households in rural Africa still do not participate in agricultural markets and most of the participants are not able to generate a significant market surplus for sale. This situation also shows the importance of supporting food crop productivity growth as part of promoting agricultural commercialisation in order to induce significant poverty reduction among smallholder farm households.

Kaminski (2011) notes that the spill-over effects of cotton production in Burkina Faso have been limited to structurally transform the economy because production growth was based less on productivity gained than on accumulation of production factors like land and labour. On the other hand, high transaction costs and low structural supports to food crop production have reduced many smallholder farmers' incentive and ability to produce for markets, as far as food and non-food crops are concerned.

In 2003, the Comprehensive African Agricultural Development Programme (CAADP) adopted in the summit of New Partnership for Africa's Development (NEPAD) in Maputo by the Governments of African countries suggested to allocate at least 10% of national budget to agricultural sector within five years in order to achieve at least 6% of growth in the sector and to meet the objective of halving the incidence of poverty as formulated in the Millennium Development Goals (MDG). Thus, in response to this commitment, Burkina Faso allocated on average 12% of public budget to agriculture and achieved a growth of 5.2% between 1990 and 2008 in the sector (OECD, 2013). However, still in OECD (2013), it is stressed that most of the investment was concentrated in cotton sector while private investment in agriculture remained limited. Therefore, the incidence of agricultural growth on poverty reduction has been lower than expected.

### **1.1.3 Concept of Agricultural Commercialisation**

Globally, agricultural commercialisation refers to increased engagement of farmers with markets in terms of crops (cash and food crops) and livestock output destined for sale. At the input side, agricultural commercialisation refers to using markets to obtain modern inputs, technical advice, as well as production factors such as hired labour, land and fund for investment. This means that commercialisation is a process which involves transformation from production for household subsistence to production for markets implying an increased integration of traditional smallholder producers into regional, national and even the world market economy. As argued by Pingali (1997), aside participation in output market, agricultural commercialisation refers to the extent to which household production choice and input use are made based on the principle of profit maximisation. This means that agricultural commercialisation can be analysed in terms of proportion of output brought to market or input use bought from market. Jayne, Haggblade, Minot, & Rashid (2011) defined agricultural commercialisation as “a virtuous cycle in which farmers intensify their use of productivity-enhancing technologies on their farms, achieve greater output per unit of land and labour, produce greater farm surpluses (or transition from deficit to surplus producers), expand their participation in markets, and ultimately raise their incomes and living standards”. Thus, agricultural commercialisation, also referred as intensity of smallholders’ market participation, can be quantitatively measured by the proportion of crop sale by the farmers with respect to crop produced. This thesis uses this latter definition but focuses only on the intensity of farmers’ participation in rain-fed agricultural output markets as a measure of their level of crop commercialisation.

## 1.2 Problem Statement

The economy of Burkina Faso is based on agriculture which is dominated by subsistence smallholder farming. The low level of farm productivity represents a central factor of persistence and pervasiveness of poverty among smallholder farmers in rural areas (IMF, 2005; Sanfo & Gérard, 2012). However, improving productivity through sustainable adoption of technology in the context of subsistence farming is challenging. As argued by Binswanger (1991), both agricultural commercialisation and technological change are closely related in such a way that while access to improved technologies is required to increase productivity and market surplus, the profitability of adopting productivity enhancing technologies is also linked to the accessibility of farm households to market and their level of commercialisation. Therefore, subsistence smallholders are generally trapped into low equilibrium of low modern input use, low productivity and low return. This has led many authors to link productivity growth and commercialisation in agriculture as crucial for rural poverty reduction (Dorosh & Mellor, 2013; Pingali & Rosegrant, 1995). In addition, promoting agricultural commercialisation through increased adoption of high value crops may fail to produce the expected outcome in the context of low productivity of staple crops and inadequate rural infrastructure (Dzanku, 2015a).

However, despite the growing interest to link smallholders to markets and improve their production and commercialisation in order to ensure national food security and alleviate rural poverty, the agricultural system in Burkina Faso remains predominantly subsistence-oriented with little incidence on rural poverty reduction. In addition, there is a dearth of empirical evidences on the drivers and effects of agricultural commercialisation on productivity and

poverty among smallholder farmers in Burkina Faso. Some existing studies include Dutilly-Diane, Sadoulet, & Janvry (2003) on the implications of market failures on farm households' resource allocation between livestock and food crop production and Kazianga & Makamu (2016) on the effect of cotton cultivation expansion on children's school enrolment and their labour supply to farming. However, these studies are limited in their scope for they do not consider the extent of farmers' level of commercialisation but instead their adoption of a specific production for market. Therefore, to inform rural development policies, there is a need for investigating the drivers of agricultural commercialisation and its impact on the wellbeing of smallholder farm households in rural Burkina Faso.

### **1.3 Research Questions**

The investigation of this study is therefore based on the following research questions:

- (i) What are the underlying factors that affect the level of agricultural commercialisation of smallholder farmers in Burkina Faso?
  - a. What are the effects of transaction costs factors on the intensity of smallholders' market supply?
  - b. Are access to productive resources key determinants of intensity of smallholders' market supply?
- (ii) Does the level of agricultural commercialisation of smallholder farmers affect their level of input use and farm productivity?

- a. What is the effect of agricultural commercialisation on fertiliser use by smallholders?
  - b. What is the relationship between agricultural commercialisation and food crop productivity?
- (iii) Are improvements in market participation and food crop productivity both needed to alleviate poverty? In other words, how does food crop yield influence the effect of agricultural commercialisation on poverty in rural Burkina Faso?

#### **1.4 Research Objectives**

The general objective of the thesis is to analyse the determinants of smallholders' market supply and the implications of agricultural commercialisation and food crop productivity for poverty reduction in rural Burkina Faso. The specific objectives are to:

- (i) Examine the underlying factors affecting smallholder farmers' marketing behaviour;
  - a. Determine the effect of transaction costs factors on smallholders' decision to participate in agricultural commercialisation and the intensity of commercialisation.
  - b. Determine the effect of access to productive resources on smallholders' decision to participate in agricultural commercialisation and the intensity of commercialisation.
- (ii) Estimate the effects of agricultural commercialisation by smallholder farmers on input use and farm productivity;
  - a. Identify the effect of agricultural commercialisation on fertiliser use.

- b. Estimate the relationship between agricultural commercialisation and food crop productivity.
- (iii) Analyse the extent to which the effect of agricultural commercialisation on rural poverty is related to the level of food crop yield.

### **1.5 Relevance of the Study**

It has for long been argued that the persistence of subsistence farming entails inefficiency and will not be viable to ensure sustainable access to food and reduce poverty in the long run (Pingali, Khwaja, & Meijer, 2005; Pingali, 1997). Subsistence households are generally the poorest and most vulnerable in rural areas and integrating smallholder farmers into the exchange economy is crucial for poverty alleviation and food security. In Burkina Faso, there is a growing emphasis of agricultural policies, namely the national programme for rural sector, on improving the competitiveness of the sector and its contribution to economic growth in which farm households will have to play a central role (FAO, 2013). Moreover, with the recurrent food crisis, the Government of Burkina Faso has recognised the importance of raising national agricultural productivity and commercialisation of farm households. Therefore, understanding the underlying factors that affect households' market supply represents an important step for designing appropriate policy for the development of smallholder agriculture.

In addition, promoting food crop productivity growth is required to meet the growing demand from a growing population and urbanisation in order to resolve the issues of food security. At the same time, land scarcity due to population pressure requires a structural transformation of agricultural sector. However, existing literature argues that agricultural

development is more pro-poor if it involves smallholders in the process of technological change and commercialisation (De Janvry & Sadoulet, 2009). Therefore, the contribution of this thesis is two-fold. First, it contributes to the limited existing literature by providing empirical evidence on the key determinants of farm households' agricultural commercialisation in Burkina Faso and the extent to which commercial farming affect and rural poverty. Secondly, understanding the farm households' marketing behaviour would also be important in informing rural development strategies towards promoting commercialisation of smallholder agriculture. This is particularly relevant in the context of Burkina Faso where subsistence agriculture and imperfect markets are widespread.

## **1.6 Organisation of the Thesis**

The rest of the thesis is organised into four chapters. Chapter Two presents a literature review on farm households marketing behaviour and the implications of agricultural commercialisation for rural households' welfare. The third chapter deals with the methodology of the thesis. The theoretical framework and empirical methods of estimation are presented for each objective of the thesis. This third chapter also presents the data source and sampling procedure. Chapter Four presents the descriptive statistics of the sample and assesses the extent of agricultural commercialisation among smallholders. In addition, it presents the findings and discussion for each objective of the study. Finally, chapter Five draws the conclusions and policy recommendations of the study.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1. Introduction

This chapter provides a theoretical and empirical overview of the determinants and effects of farm households' marketing behaviour in developing countries. The first section emphasises the role of transaction costs and access to productive resources in farm households' market supply. The second section reviews the literature on poverty effects of agricultural commercialisation and productivity among smallholder farmers.

#### 2.2. Smallholder Farmers' Marketing Behaviour in Developing Countries

It is well known that price response of farm households' output supply in developing countries is generally low. This led early studies to raise some scepticisms about the usefulness of price policies in the agricultural sector. However, with the development of non-separable farm household models, formalised by Singh, Squire, & Strauss (1986) and afterwards by De Janvry *et al.* (1991), the rationality of farm households' marketing behaviour is commonly analysed in the context of imperfection of rural markets in which getting price right is seen as not enough to induce an adequate response of farmers. Indeed, high level of transaction costs are responsible for significant market imperfection in developing countries (De Janvry & Sadoulet, 1993; Goetz, 1992). In addition, production constraints in certain situations limit the quantity that can be exchanged. Therefore, price and non-price barriers are important determinants in the level of farm households' market integration.

### **2.2.1. Farm Households' Market Supply in the Presence of Transaction Costs**

Ronald Coase in 1937, was the first to introduce the notion of transaction costs in his attempt to define the relationship between firms and markets (as cited by Chamberlin & Jayne (2013) and Escobal (2001)). Coase considered that market exchange is not costless and that the organisation of firms and other contract arrangements are aimed at reducing transaction costs. Afterwards, the concept of transaction costs has been more emphasised in the framework of New Institutional Economics (NIE) where, it is referred to as hidden costs of accessing markets. The New Institutional Economics is based on the neoclassical economic theory but relaxes the hypothesis of perfect information and costless exchange and emphasises the importance of institutions as a means to reduce high transaction costs.

In the agricultural sector, the role of transaction costs in farm households' market participation has been widely emphasised (Goetz, 1992; Key *et al.*, 2000). Transaction costs are often categorised into fixed (FTCs) and proportional transaction costs (PTCs). FTCs include the costs of (a) searching for a buyer or a market with best price, (b) negotiating and bargaining, particularly when there is information asymmetry about prices, and (c) enforcement of contracts and supervision, as sellers have to screen buyers for reliability and lower the likelihood of defaults of payment, particularly when credit sales are involved. Fixed transaction costs are invariant with the volume of trade. For instance, a farmer may incur the same searching cost to sell either one metric ton or five metric tons of a product. Once the seller has obtained the information about the market of the product and enters in contact with the buyer, he can therefore sell any amount without having to incur extra costs. Evidence shows that fixed transaction costs affect only the decision of whether

or not to participate in the market but not the volume of trade (Burke, Myers, & Jayne, 2015; Goetz, 1992; Key *et al.*, 2000).

Proportional Transaction Costs (PTCs), on the other hand, influence agricultural commercialisation at different levels of the process, including the decision to participate in the market and the intensity of participation (Key *et al.*, 2000). PTCs encompass costs of transferring the product being traded, i.e. transportation and time spent to deliver the product and other marketing costs. PTCs lower the price effectively received by the sellers and raise the price effectively paid by the buyers thereby creating a price band within which some households may find unprofitable to participate in the market. In addition, there may exist some variable transaction costs that are not proportional to the volume traded. Analysing farm households' supply response to price, Henning & Henningsen (2007) developed a model that shows the influence of non-proportional variable transaction costs on farm households' behaviour. Applied to a study on Poland farmers' participation in labour markets, they found that the presence of non-proportional transaction costs explains the imperfection of labour markets and the non-separability of farm households' production and consumption decisions even if they participate in the market as sellers or buyers of labour.

Numerous markets are imperfect in rural areas or in extreme cases, are missing due to high transaction costs which impede market exchange to take place. Factor markets such as land, labour and credit markets as well as output markets such as food crops, function imperfectly in many rural areas. This constrains rural households to consider their consumption needs in making production and commercialisation decision. For instance, a household producing cash crops would not

positively respond to an increase of price in presence of high transaction costs in food market or imperfect labour market to allow hiring (Fafchamps, 1992). For instance, the imperfection in labour markets makes households' consumption and production decision non-separable and limits their output supply (Henning & Henningsen, 2007). Though technology adoption could be a panacea in absence of labour market, as noted by World Bank (2008), credit constraint can reduce the possibility of this option. Therefore, when market access is highly costly, the household will increase its reliance on own production and resources (i.e. labour, land). This may result in increase in on-farm diversification generally at expense of productivity gained through specialisation (Omamo, 1998a).

Concerning the specific case of output market, recent studies have provided substantial evidence on the role of transaction costs and institutional factors on farm households' market participation. However, empirical studies face challenges in measuring the magnitude of transaction costs because they are generally unobservable and difficult to record in a survey (Key *et al.*, 2000). Therefore, an indirect approach consisting of using observable factors that are assumed to affect the costs of accessing markets is commonly used to assess the effect of transaction costs on agricultural commercialisation. Numerous authors adopted this approach and considered factors such as information access, quality of roads and transportation equipment, membership to marketing association and asset endowments as indicators of level of transaction costs that the households face (Alene *et al.*, 2008; Barrett, 2008; Goetz, 1992). In fact, transaction costs tend to be higher for farmers living in remote areas with poor communication and transportation infrastructure (Renkow, Hallstrom, & Karanja, 2004). Therefore, distance to market, poor

infrastructure and poor access to assets and information increase the exchange costs and can be high enough to hamper many transactions to take place.

In his pioneering work, Goetz (1992) estimated a Heckman switching regression model of market participation and quantity of trade in Senegal grain market, separating the participation decision from the amount traded. His results suggested that fixed transaction costs represent a key barrier of smallholder farmers' market participation while better access to information improves their participation. Alene *et al.* (2008) adopting a similar model for the case of maize supply by smallholders in Kenya, confirmed the negative effect of transaction costs on market supply and suggested that factors that reduce transaction costs, including institutional innovations (i.e. group marketing), can mitigate the cost of accessing market and improve market supply. Key *et al.* (2000) developed a structural model of supply and demand functions to analyse the proportional and fixed transaction costs effects. Their model highlighted the fact that, while fixed transaction costs affect only the decision to participate in markets, the proportional transaction costs affect both the decision of market entry and quantity of sale. Applied to Mexican corn market, they found that 60% of an increase in output supply in response to price growth is due to producers that enter the market as sellers while the remaining 40% is explained by the response of producers that are already sellers. Shilpi & Umali-deininger (2007) in the case of India found that improvement in market facilities and decrease in travel time from the village to the market significantly increase the likelihood of sales in the market which positively affects rural income particularly among poorer farmers.

Access to information also plays a key role in households' market supply by affecting the level of transaction costs. This factor has also received much attention in the literature, especially with the introduction of the mobile phone and information technology in developing countries. Information access is expected to reduce transaction costs, increase market integration and lead to a shift to commercial agriculture. In a study on maize and groundnut farmers in Northern Ghana, Courtois & Subervie (2015) found that by reducing information asymmetry between buyers and itinerant traders, mobile-based Market Information Service (MIS) increases price received by maize and groundnut farmers by about 10% and 7% respectively. Jensen (2007) showed that price dispersion in India's fish market dramatically reduced after introduction of mobile phone resulting in increase in fishermen's profit and consumers' welfare. Aker (2010) found that introduction of mobile phone in Niger reduced grain market price dispersion from 10% to 16% between 2001 and 2006.

However, some studies found no significant effect of introduction of mobile phone on farm households' market supply. Indeed, Muto & Yamano (2009) using household survey data from 2003 and 2005 in Uganda found that the introduction of mobile phone has increased farmers' participation in banana market that is a perishable crop but not in maize market. Similar results are found by Fafchamps & Minten (2012) who estimated the benefits for farmers of SMS based agricultural information in India, using a randomised controlled trial. Their findings showed that SMS based agricultural information had no significant effect on the prices received by farmers, value added, crop losses, crop choices, and cultivation practices.

There are also a number of authors who attempted to quantify the magnitude of transaction costs faced by farm households in accessing markets. Renkow *et al.* (2004) undertook this exercise for

the case of semi-subsistence households in Kenya. Using a structural model of household demand and supply functions, they investigated the extent to which an autarkic household needed to be compensated with higher market prices to offset the fixed transaction costs that make him to either sell or buy in the market. They found an average of 15% of ad valorem tax equivalent of transaction costs which positively varies with the level of economic isolation of rural areas. In Latin-America, Vakis *et al.* (2003) also assessed the extent of transaction costs faced by Peruvian potato farmers, using a market choice model. They found that the information on market price that farmers receive from their neighbours reduces fixed transactions costs by the equivalent of double of the price received, and was equal to four times the average transportation costs. Escobal (2001) estimated the transaction costs at 50% to 60% of sale value for famers who are connected to market without a motorised track in Peru. He also found that smallholders face higher transaction costs (estimated at 67% of sale value) than the large farmers (32%).

### **2.2.2. Smallholder Farmers' Marketing Behaviour: An Asset-Based Approach**

Though improving physical market access and reducing transaction costs have important implications in farm households' market participation, their supply response may still remain low in the absence of adequate access to productive resources such as land and equipment. Access to productive technology and public goods are important for farm households to produce a significant surplus that can be marketed (Barrett, 2008). Thus, households' characteristics and asset endowment, such as livestock, and ownership of land and transportation equipment, are likely to affect their likelihood to participate in the market as sellers by increasing market surplus but also by reducing transaction costs.

Fafchamps & Hill (2005) showed that when the quantity to be sold are large and/or the market is closer, Uganda coffee farmers, particularly better-off farmers, are more likely to sell in the market where they can get better price. Boughton *et al.* (2007) in a study on Mozambique farm households' supply showed that private assets, especially land, livestock, labour and equipment have significant effects on the likelihood of farm households' crop market participation and the earnings are positively correlated with quantity of land holding. Barrett (2008) argues that the likelihood of farm households to be gross buyers in the market is high among those with smaller land size. However, this probability reduces steadily with the increase of household's land holdings. Livestock contributes to increased productivity and surplus for market if it is well integrated with crop farming. Alene *et al.* (2008) found a significant effect of livestock ownership on quantity sold but no significant effect on decision to participate in the market. Using a double hurdle model, Olwande, Smale, Mathenge, Place, & Mithöfer (2015) showed the importance of access to land, productive assets and technology use for smallholder participation in agricultural market in Kenya.

### **2.2.3. Analysing Smallholders Farmers' Market Participation: A Methodological Review**

Empirical studies commonly face the challenge of dealing with the issue of possible selection bias in estimating the determinants of farm households' participation in agricultural commercialisation. The problem may arise because farmers have to make two distinct decisions. In general, the first is a discrete choice of whether or not to participate in a given market as seller or buyer; and secondly to decide on the amount to buy or sell conditional on the first decision. Theoretically, factors that affect the second decision concerning the quantity to trade are also likely to affect the

discrete choice of market participation. However, some factors such as fixe transaction costs would affect only the first decision to participate in the market but not necessarily the quantity of sale (Key *et al.*, 2000). In addition, if some unobservable factors such as risk aversion and liquidity constraints affect both participation decision and intensity of participation, then the error terms of both regressions will be correlated. In this case, estimating each stage separately will lead to biased estimates.

To correct the problem of selection bias, Goetz (1992) adopted Heckman switching regression in his study on grain market in Senegal. This consisted of first estimating a Probit model of market participation (as seller or buyer) and then a regression model of quantity traded (sold or bought). Thus, the Inverse of Mills Ratio (IMR) is included in the second stage to correct the problem of selection bias. This model has since been used in numerous similar studies (Alene *et al.* (2008) in Kenya; Boughton *et al.* (2007) and Heltberg & Tarp (2002) in Mozambique). In a study on agricultural commercialisation in five European Union countries, Fredriksson, Bailey, Davidova, Gorton, & Traikova (2017) found that the IMR in Heckman model was not significant suggesting an absence of selection bias. They therefore, explained the observed subsistence behaviour of smallholders as a consequence of observed factors such households' endowments in productive assets and technology as well as geographic location. However, these findings are different from those in developing countries where sample selection due to unobservable factors have been frequently emphasised. An alternative approach used is a simultaneous estimation of the structural supply and demand functions and production functions as adopted by Key *et al.* (2000).

However, these methods rely on the implicit assumption that the decision to participate in the market and the intensity of participation are made simultaneously. Bellemare & Barrett (2006) showed instead that in the case of livestock markets in Kenya and Ethiopia, farm households follow a sequential process of decision making which make them less subject to exploitation by traders. To take into account this fact of a sequential decision process, they developed an ordered Tobit model to analyse farm households' market supply. Takeshima & Winter-Nelson (2012) confirmed a sequential decision of participation and intensity of participation by smallholder farmers in Cassava market in Benin and adopted a double hurdle model. In addition, if farm households' market participation is more constrained by their capability to produce a market surplus, their decision may be analysed as a rational choice and not necessarily as a self-selection problem due to prohibitive transaction costs. This has led numerous authors to prefer a corner solution models such as Tobit or double hurdle models (Burke *et al.*, 2015; Holloway & Barrett, 2005; Mather, Boughton, & Jayne, 2013; Olwande *et al.*, 2015). Table 2.1 reports some recent studies and methods used to explain farm households' marketing behaviour.

The studies that use Heckman selection model most often aimed at explaining the inability of farmers to sell their market surplus due to the existence of high transaction costs in the markets while methods such as double hurdle model assume that participation decision is a rational choice of farmers which depends both on transaction costs but also farmers' level of productive assets. Thus, the double hurdle model will be used in this study to examine the determinants of farm households' participation in agricultural output markets in Burkina Faso.

**Table 2.1: Methods Used in Analysing Smallholders' Market Participation in Developing Countries**

<b>Authors</b>	<b>Countries</b>	<b>Crops</b>	<b>Methods used</b>
Goetz, (1992)	Senegal	Grains	Heckman switching regression
Key <i>et al.</i> (2000)	Mexico	Corn	Structural model of demand and supply functions
Renkow <i>et al.</i> (2004)	Kenya	Maize	Structural model of demand and supply functions
Bellemare & Barrett (2006)	Kenya and Ethiopia	Livestock	Ordered Tobit
Boughton <i>et al.</i> (2007)	Mozambique	Maize, Cotton, Tobacco	Heckman switching regression
Alene <i>et al.</i> (2008)	Kenya	Maize	Heckman switching regression
Takeshima & Winter-Nelson (2012)	Benin	Cassava	Double Hurdle model
Burke <i>et al.</i> (2015)	Kenya	Dairy	Triple hurdle model
Mather <i>et al.</i> (2013)	Southern and Eastern Africa	Maize	Double Hurdle model
Olwande <i>et al.</i> (2015)	Kenya	Maize, kale and dairy	Double hurdle with lognormal specification
Fredriksson <i>et al.</i> (2017)	Five European Union countries	All crops produced	Heckman switching regression

### **2.3. Agricultural Commercialisation and Rural Poverty in Developing Countries**

This section explores the literature on the relationship between agricultural commercialisation and productivity, briefly discusses the relationship between agricultural productivity and rural poverty and finally reviews the empirical studies on the effect of agricultural commercialisation on the welfare of rural households.

#### **2.3.1. Agricultural Commercialisation, Market Access and Food Crop Productivity**

Based on comparative advantage, Timmer (1997) argues that commercialisation in agriculture would increase specialisation at farm household level resulting in efficiency gain and improvement in farm households' welfare. Furthermore, following the literature on international trade, it is also argued that the welfare gained through market participation is not only static as stated in the comparative advantage theory; it may also result from a dynamic technological change due to increased competition and adoption and better use of technology (Barrett, 2008).

The literature generally identifies two pathways through which agricultural commercialisation can affect food crop yield; namely, through household level synergies and regional spill-over effects (Govere & Jayne, 2003; Govere, Jayne, & Nyoro, 1999). The former refers to the situation where participation in commercial farming scheme enables farmers to acquire resources for food crop production that otherwise will not be available. This is particularly frequent in African countries where the failure of credit and input markets makes the adoption of non-food cash crop farming the primary means for acquiring input that can be used in other crop production. Regional spill-over effects, on other hand, happen

when commercialisation attracts more investment in the region which benefit all farmers in the region regardless of whether they are engaged in commercialisation or not. This is because commercial crop producers tend to adopt productive technologies, thereby attracting investment in agricultural innovations. In a study on cotton sector in Zimbabwe, Govereh & Jayne (2003) found strong evidence of positive effect of cash crop production on food crop productivity. Further, their results highlight important regional spill-over effects of cotton production on the overall agricultural sector. Govereh et al. (1999) also found that farmers that are engaged in commercial agriculture adopt more productive technology and achieve higher level of productivity in Kenya than those that are engaged in subsistence farming only.

In a cross country study including several developing countries, Rios *et al.* (2009) investigated a bidirectional relationship between commercialisation and farm productivity. Using instrumental variables, and measuring commercial orientation of households by the proportion of agricultural output sold, they found a significant influence of productivity on commercialisation index but found no significant evidence to support the inverse relationship, i.e. the effect of agricultural commercialisation on productivity. Bekele, Belay, Legesse, & Lemma (2010) undertook a similar study in Ethiopia and estimated a censored simultaneous equation model of a relationship between commercialisation and productivity. However, contrary to Rios *et al.* (2009), their results indicated only a strong and unidirectional effect of commercialisation on productivity. The difference in these findings reveals the specificity of commercialisation process in the different countries. In addition, the potential endogeneity of crop commercialisation index in this relationship represents a challenge in obtaining consistent estimators, when good instruments are not identified. After controlling for the endogeneity of commercialisation, Ochieng, Knerr, Owuor, & Ouma

(2016) found strong evidence of the effect of commercialisation on food crop productivity and use of improved seed varieties in Central Africa.

Market conditions and the availability of rural infrastructure also affect farm productivity through improved access to inputs and services (Renkow *et al.*, 2004; Stifel & Minten, 2008). Indeed, rural road networks have been linked with higher agricultural wages, crop production and food availability (Khandker, Bakht, & Koolwal, 2006; Mu & Walle, 2007) and increase in non-agricultural opportunities in developing countries (Escobal, 2001; Escobal & Ponce, 2002). Escobal & Torero (2005) show that improved market access, through access to public services, enhances the productivity of households' private assets which is referred to as asset complementarities. Proximity to urban centres is also shown to be positively correlated with agricultural productivity (Dorosh, Wang, & Schmidt, 2010) and specialisation (Fafchamps & Shilpi, 2008).

Furthermore, using a trans-log production function, Stifel & Minten (2008) found that yields of major staple crops (rice, maize and cassava) in Madagascar strongly reduce as the distance to major markets increases, while the quantity of agricultural input used declines with rural remoteness. Their findings also show a strong relationship between poverty and isolation captured by transport infrastructure and distance to markets. In addition, Omamo (1998b) found that the presence of transaction costs due to bad transportation conditions may also explain the seemingly inefficient cropping choices of farmers, where the most important resources are allocated to low value food crops instead of cash crops that have higher market returns. This supports the findings that show that farm households shift out of cash crops that

are perishable (e.g., vegetables and fruits) into hardier and more storable crops such as grains, as the distance to market centres is increasing.

Stifel & Minten (2008) also point out that poor access to market reduces technology use and farm productivity by increasing rural market segmentation and price instability. Therefore, in the absence of adequate financial markets (credit and insurance) to cover price and income risks, households would be more likely to accept lower income activities for lower income variance. Similarly, in a recent study, Damania *et al.* (2016) showed that constraints to technology adoption and market participation are likely to be closely linked if fixed costs of technology adoption is high, suggesting that policies that reduce transportation costs will impact technology adoption, productivity and then market participation. This finding suggested that the reduction of transport costs and travel times, particularly in the remote areas, would enhance the market size for households in these localities.

### **2.3.2. Innovation Adoption, Farm Productivity and Rural Poverty**

The role of agricultural productivity growth in poverty reduction in developing countries has been highlighted in various empirical studies (Byerlee, De Janvry, & Sadoulet, 2009; Datt & Ravallion, 1998; Dzanku, 2015b; Irz, Lin, Thirtle, & Wiggins, 2001; Minten & Barrett, 2008). In theoretical perspective, by generating farm and non-farm employment, agricultural productivity has direct and indirect effects on rural poverty (Schneider & Gugerty, 2011). The direct effect resides in the fact that output growth affects market surplus and increases household income from crop sales. The gain in labour productivity also gives households the possibility to allocate labour force to non-farm activities. This diversification improves

income and resilience, but can also in return, sustain investment in agricultural productivity enhancement.

Datt & Ravallion (1998) emphasised the indirect effect of agricultural productivity growth on rural households' livelihood outcomes through price and wage variations. Indeed, growth in agricultural sector stimulates the demand for labour and increases employment and wages. At the same time, output growth leads to price fall which improves real wage and food access for farm workers, rural landless and urban poor. Poor urban households who allocate a high amount of their income to food consumption also experiences these indirect benefits. However, Minten & Barrett (2008) showed that price effect on welfare of rural poorest will not warm net sellers, if technological change effect in productivity gain is greater than price fall. Janvry & Sadoulet (2009) observing the increase in tradability of agricultural product and the improvement in market environment in many countries, optimistically predicted that welfare gain from productivity growth will be more important than welfare loss from price fall in the future; which represents an opportunity to stimulate smallholders' market orientation. In addition, especially in Asia as well as in Sub-Saharan Africa (SSA), literature has highlighted the existence of a strong multiplier effect of agriculture on nonfarm activities.

In empirical perspectives, it is shown that not only growth in agriculture has a strong poverty reduction effect but also economic growth induced by the growth in agriculture is more profitable to the poor than a similar growth that is generated by non-agricultural sector. In cross-country analysis (focusing on developing countries), Janvry & Sadoulet (2009) showed that on average GDP growth that originates in agriculture is three time more effective for poverty reduction than growth that originates in other sectors of the economy. Furthermore,

they showed that 10% growth in cereal yields in East Asia is accompanied by over 53% decline in rural poverty. Similar results are found in Eastern Europe and Central Asia. In Sub-Saharan Africa, however, their findings described a stagnation of cereal yield and rural poverty whilst in Latin America, the growth of cereal crop yield did not provide significant poverty reduction. These differences are believed to be related to the nature of technological change and the importance of smallholder agriculture. Thus, De Janvry, & Sadoulet (2009) noted that the green revolution in Asia was able to absorb more labour and reduce poverty because the increase in land productivity was faster than that of labour productivity. Thus, technology change in Asia was scale neutral and labour intensive which allowed significant labour absorption in farming. In the case of Brazil in Latin America, technical change was mainly capital intensive and labour saving. This system was more favourable for large scale farming and provided low employment opportunity.

Micro evidence also sustains the role of agriculture in rural development. Using data from 1950 to 1990 for rural India, Datt & Ravallion (1998) found that yield growth has both direct effect on poverty reduction and indirect effect through wage rate increase and decrease in food prices. In rural Madagascar, Minten & Barrett (2008) studied how productivity is linked to rural poverty reduction. Their findings suggested that, regions that have higher rates of adoption of improved agricultural technologies have higher crop yields, resulting in lower food prices, higher real wages for unskilled workers, and better welfare indicators in terms of rural poverty reduction and food security. In a study of rural China, Christiaensen, Demery, & Kuhl (2011) found about three times more efficient of using agriculture to improve income of poorest households, (i.e. those living with less than one dollar (1\$) per day), compared to non-agricultural sector. Studying the effect of farm productivity on three

different indicators of rural households' welfare in Ghana, Dzanku (2015b) found a significant effect of productivity gain per labour on rural welfare regardless of the measure of welfare used. Thus, these empirical findings establish how important agricultural growth and improvement of smallholder commercial orientation are for the reduction of rural poverty.

### **2.3.3. Agricultural Commercialisation and Smallholders' Welfare in Developing Countries**

Agricultural commercialisation of smallholders is expected to lead to a virtuous circle of improved efficiency, income and food security as opposed to vicious circle of subsistence farming that keeps smallholders in low input use and low returns. As noted by De Janvry & Sadoulet (2009), promoting agricultural growth and market-oriented smallholder farming represent the most effective way in strengthening the link between technology, productivity and poverty reduction. In particular, commercial farming of smallholders can induce significant poverty reduction by improving the dynamics of the rural economy through higher expenditure of commercial farmers on labour-intensive, non-tradable, rural non-farm sector, thereby increasing incomes for the rural nonfarm population (Mellor & Malik, 2017).

However, evidence on the link between agricultural commercialisation and households' welfare is not conclusive. In the early studies, the assessment of welfare effects based on restrictive definition of agricultural commercialisation which subjectively distinguished adopters and non-adopters of a given list of cash crops, provided evidence that was not comparable across countries. To avoid this crude dichotomous definition of agricultural commercialisation, Von Braun (1995) suggested an assessment based on the proportion of

output that households sell with respect to the quantity harvested, regardless of the type of crops involved. He further developed a conceptual framework showing how both macroeconomic and microeconomic factors affect farm households' level of commercialisation and its effects on food security and nutrition at household, community and national levels. Thus, under conducive macroeconomic environment, adequate infrastructure and institutional framework, commercialisation will lead to improved welfare at national and household levels, if income is adequately used and intra-household factors do not distort households' resource allocation against food expenditure. However, this theoretical and conceptual construction is not supported by empirical evidence.

Recently, there is a growing literature that supports a strong positive effect of market-oriented agriculture on rural households' welfare and more on global economic growth and development. Mellor & Malik (2017) found out that agricultural growth and increase in commercialisation are central determinants of rural poverty reduction in middle and low income countries. In addition, in low income countries, their findings indicated that small commercial farming represents the strongest determinants of rural income growth and poverty reduction. Papaioannou & de Haas (2017) showed that the negative impact of weather shocks is mitigated with increase in agricultural commercialisation, involving export crops.

However, the literature highlighted numerous factors that can also induce perverse effects of commercialisation, particularly among the poorest smallholder farmers. In this regard, Stephens & Barrett (2009) showed that market participation which consists of selling output at low price in post-harvest period due to lack of access to credit and off-farm opportunities,

while buying at high price in lean season, has detrimental effect on households' welfare and gets farmers into a poverty trap. Wood, Nelson, Kilic, & Murray (2013) estimated the effect of adoption of cash crop (tobacco) production by Malawian farmers on their child nutrition status. They found that tobacco production in the year of child birth combined with food price escalation lowers their height-for-age z-scores. However, among those who were not exposed to price shock, no statistically negative evidence was identified. Muriithi & Matz (2014) investigated the effect of commercialisation of vegetable crops on Kenyan smallholders' welfare measured by income per capita and assets index based on two years panel data. Their findings highlighted a significant and positive effect of commercialisation of vegetables in international markets (export) on income but no significant effect on households' asset holding. Moreover, commercialisation in domestic market showed no strong evidence in welfare improvement. Similarly, in a cross-country study, Carletto, Corral, & Guelfi (2017) used pooled data, adopted Von Braun's (1995) definition of agricultural commercialisation, and estimated its effect on households' food expenditure and children anthropometric measures. No significant evidence was found to support a positive effect of commercialisation. Furthermore, they pointed out a perverse effect of female market participation on children welfare (i.e. anthropometric measures).

The imperfection of food market induced by the level of transaction costs and the importance of share of food expenditure in rural households' budget were among the factors that led some authors to consider food crop productivity growth in Africa as having the greatest potential within the agricultural sector for effective poverty reduction (Barrett, 2008; De Janvry & Sadoulet, 2009; Diao & Pratt, 2007). Diao *et al.* (2007) stressed that a strategy of raising agricultural growth based on promoting export crop production may not lead to

significant global income growth, while increases in yield and production of staple food crops support higher growth in agriculture and greater reduction in poverty, particularly when there is a dynamic nonfarm economy to raise the demand of agricultural products with a relatively low marketing costs. Al-Hassan & Diao (2007) showed that agricultural-led growth particularly staple food crops in Northern Ghana has larger poverty reducing effect than growth outside agriculture, in export crop sector. In addition, using a panel dataset from farm households in Ghana, Dzanku (2015a) found that promotion of high value crops may not induce significant income growth among farmers when staple crop yield is low. The high potential of food crop productivity also resides in the fact that it directly contributes to different aspect of food security by increasing producers' income and employment and also by stabilising food supply and prices which benefits rural and urban net buyers.

#### **2.4. Conclusion**

Literature review indicates that globally price and non-price factors can be identified as determinants of farm households' market supply. Non-price factors such as transaction costs, access to productive assets and public infrastructure are among the factors that can influence farmers' market participation. In addition, the review reveals that the empirical evidence on the relationship between agricultural commercialisation and poverty among farm households is not conclusive and depends on numerous factors. Indeed, while there is an increasing view supporting increased commercialisation of smallholders, some challenges such as low productivity may reduce the benefit of commercialisation for them. Therefore, further research is required to highlight the implications of promoting smallholders' agricultural commercialisation and the extent to which food crop yields can sharpen this relationship.

## CHAPTER THREE

### METHODOLOGY

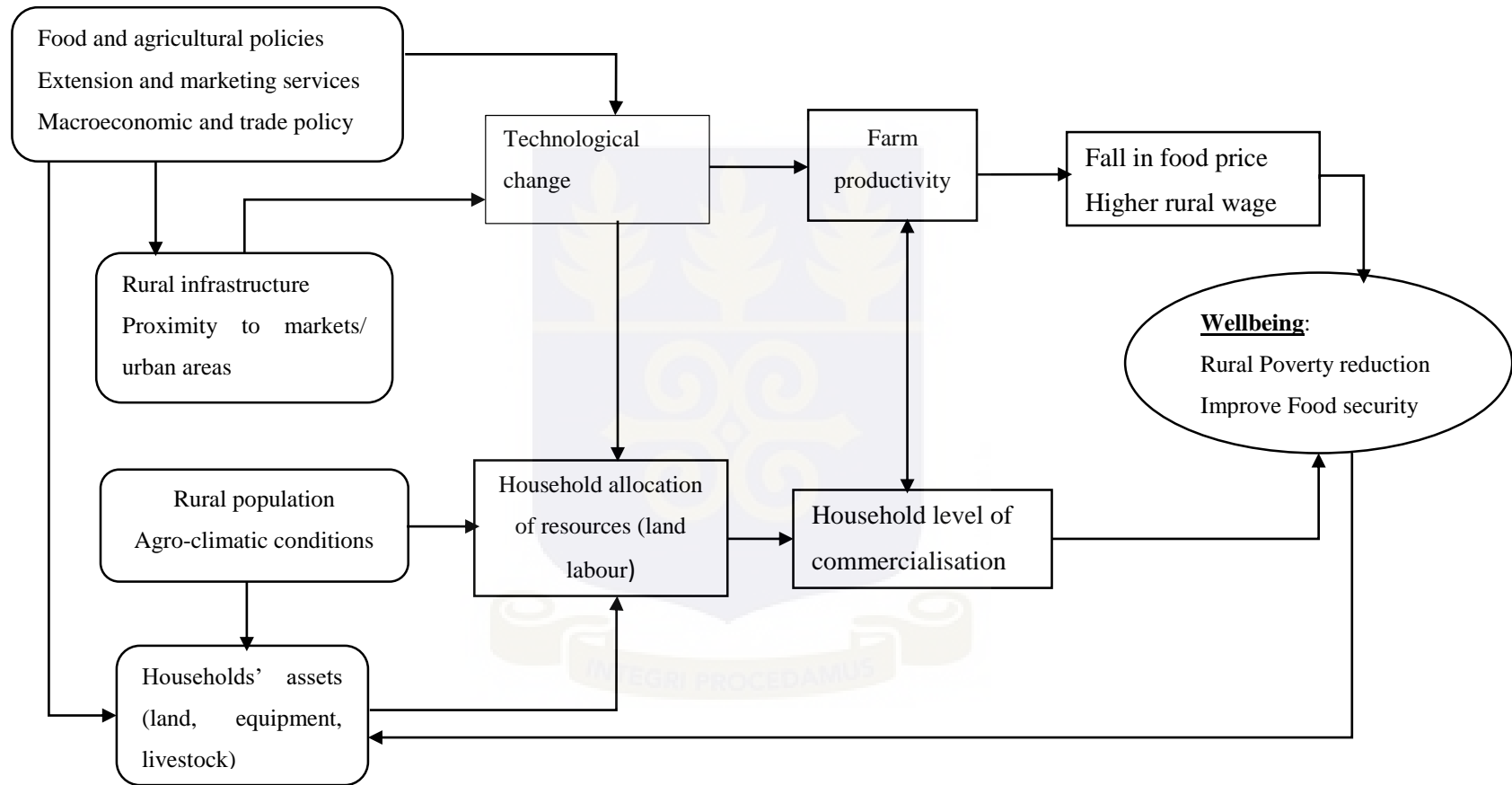
#### 3.1. Introduction

The theoretical framework and empirical methods of analysis for each objective of the study are presented in this chapter. First of all, the conceptual framework is described. Furthermore, the theoretical and empirical methods used to analyse the determinants of farm households' level of commercialisation are presented. A partial equilibrium model establishing the link between agricultural commercialisation, innovation adoption, farm productivity and rural poverty is developed in the third section. Based on this framework, the empirical methods for analysing the second and the third objectives are provided. Finally, the fourth section describes the data source and sampling procedure.

#### 3.2. Conceptual Framework

Several studies identified agricultural commercialisation as an indispensable pathway towards economic growth and development in developing countries (See Pingali & Rosegrant, 1995; Von Braun, 1995). The conceptual framework developed in this study (Figure 3.1) highlights the key explanatory factors of agricultural commercialisation and its effect on rural households' wellbeing. The drivers include community characteristics such as availability of rural infrastructure and accessibility to urban areas and markets. The improvement of physical infrastructure and household access to information would positively affect household level of commercialisation by reducing transaction costs (Renkow *et al.*, 2004) and speeding price adjustment across markets (Aker, 2010).

**Figure 3.1: Agricultural Commercialisation: Determinants and Effects on Rural households' Wellbeing**



Source: Author

In addition, adequate policies and institutional arrangements combined with the development of rural infrastructure and services improve the access to markets and strengthen the linkages between urban and rural areas. The other drivers of agricultural transformation include, sound macroeconomic and trade policies, that make agricultural markets profitable for smallholders (Von Braun, 1995). These macroeconomic framework and national agricultural policies combined with physical accessibility of rural areas would determine the level of adoption of innovations by farm households, and technological change in rural economy.

On the other hand, farmers' resource allocation to different activities including subsistence, commercial and nonfarm activities depend on various factors such as their initial assets endowment, agro-climatic conditions and the availability of technology that they can afford. Thus, farm households that are located in more suitable agro-climatic zones would be more productive and more likely to allocate more resources for commercial farming. In addition, asset holdings such as land and agricultural equipment, as well as access to inputs, will improve the extent of household's agricultural commercialisation.

Increased agricultural commercialisation may directly affect productivity by increasing specialisation when numerous markets are accessible for farmers. In addition, commercial orientation is generally an avenue for farmers to get better access to modern inputs because households that are more commercially oriented would be more willing to adopt yield enhancing technology than subsistence farmers (Govereh & Jayne, 2003). Thus, this will result in higher crop productivity. There may also be a bidirectional relationship between agricultural commercialisation and farm productivity in that, an increase in productivity

raises households' market surplus and can lead to higher level of commercialisation (Bekele *et al.*, 2010; Rios *et al.*, 2009).

Higher level of agricultural commercialisation among smallholders and improved yield will increase rural income and reduce the incidence of poverty. Thus, acting as a vehicle for improved technology adoption and technological change, market participation increases productivity resulting in lower food price which benefits the net buyers of food and off-farm workers. Productivity growth will result in increased demand for labour and in higher wage rate while increase in expenditure on rural non-traded goods increases the opportunities of nonfarm employment for rural workers (Mellor & Malik, 2017; Minten & Barrett, 2008). Therefore, agricultural commercialisation and productivity growth would result in income growth both for households that are commercialising their crops and for households that are supplying their labour. This will result in reduction of poverty incidence and improved food security among rural households while income gain in turn can improve farm households' asset accumulation and resource allocation towards commercial farming. The long run effect would be a specialised farm household production system and increased crop diversification at national level.

### **3.3. Analysing the Determinants of Agricultural Commercialisation of Smallholder Farmers**

#### **3.3.1. Theoretical Framework of Farm Households' Marketing Behaviour**

The particular feature of farm households in developing countries is the fact that they are both producers and consumers of crops and the imperfection of markets makes their production and consumption decisions non-separable. As producers, they make resource allocation decision (labour, land, etc.) to different crop production and the quantity of labour to hire in order to maximise farm profit. As consumers, they have to make the decision on the allocation of income gained from various activities to consumption and the decision on the amount of labour to allocate to off-farm activities in order to maximise their utility (Taylor, Zezza, & Gurkan, 2008). If markets exist and function perfectly for all goods, including labour and other inputs, the optimal production decision that maximises farm profit consists for a given household to allocate its resource according to its comparative advantage which would lead to more specialisation of agricultural production. Thus, with market exchange under this condition, the household maximises its utility by choosing the quantity of goods to buy from the market and labour to offer in off-farm activities (or leisure) subject to budget constraints. Therefore, when markets function perfectly, household decision becomes separable and can be analysed in the framework of standard microeconomic theory of consumer and producer.

However, farm households must overcome high costs to participate in markets. In addition, constraints to accessing productive assets may keep some farmers out of market. Therefore, the theoretical framework presented is a farm household model in which transaction costs

and productive resources affect farm households' marketing behaviour. This model considers a general case where households can participate in the markets as buyers or sellers of crops. Based on a farm household model developed in a context of transaction costs by Barrett (2008), the key general feature is that each household presents an unique position vis-à-vis the markets (i.e. as buyer, seller or autarkic) because transaction costs that they face are household-specific.

A representative farm household maximises its utility by choosing a consumption bundle composed of agricultural commodities that he produces,  $Q_c$  (for  $c = 1, \dots, C$  indicating the crops produced by the household) and other consumption goods  $x$  purchased in the market. His income sources include production and commercialisation of any or all  $C$  crops and off-farm activities ( $Y$ ). Production technology  $f_c(A_c, I_c, G)$  is assumed to be crop-specific. The function  $f_c(A_c, I_c, G)$  depends on household productive assets such as labour and land, livestock, and physical equipment (ownership of transportation and communication equipment), represented by the vector  $A$  and other production factors such as inputs,  $I$  (e.g. fertiliser, pesticides and seeds). Production function is also affected by the availability of public goods and services  $G$ , such as extension services, farmer associations, road quality, etc. Farmer chooses to participate in the market of each crop  $c$  either as seller or buyer.  $M_{cs}$  is a binary variable of market participation as seller whose element takes the value 1 if the household participates in the market as seller, and 0 otherwise. Similarly,  $M_{cb}$  represents the buyer's side of market participation taking the value 1 for each crop that the household buys and 0 if not.

The net sale of a given crop is  $NS_c \equiv f_c(A_c, I_c, G) - Q_c$ <sup>3</sup> with  $c = 1, \dots, C$  which is positive if and only if  $M_{cs} = 1$  and negative if and only if  $M_{cb} = 1$ . Household that participates in the market faces the market price for each crop  $P_{cm}$  and the level of transaction cost  $\tau_c(Z, A, G, Y, NS_c)$ . Thus, the price of each crop is household specific and can be expressed according to the position of each household in the market as follows:

$$\begin{aligned} P_c^* &= P_{cm} + \tau_c(Z, A, G, Y, NS_c) && \text{if } M_{cb} = 1, \text{ i.e. household is net buyer of the crop } c \\ P_c^* &= P_{cm} - \tau_c(Z, A, G, Y, NS_c) && \text{if } M_{cs} = 1, \text{ i.e. household is net seller of the crop } c \\ P_c^* &= P_a && \text{if } M_{cb} = M_{cs} = 0, \text{ i.e. the household is autarkic for crop } c \end{aligned}$$

$P_{cm}$  is the price of crop  $c$  in the local market,  $P_a$  is the autarkic shadow price that exactly equates household demand and supply. The transaction costs  $\tau_c(Z, A, G, Y, NS_c)$  for each crop  $c$  is function of public goods and services ( $G$ ) (extension service, information on crop marketing strategy, road quality, distance to markets), household specific characteristics ( $Z$ ) (gender, education, age that may affect search cost and negotiation skills), household assets ( $A$ ), income from non-farm earnings ( $Y$ ) and the volume of net sale ( $NS_c$ ).

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<sup>3</sup> This formulation deals with a static problem of farm household marketing behaviour. Thus by considering the net sale of farmer, it is assumed that a given household is either seller or buyer such that the following equality always holds  $M_{cs} * M_{cb} = 0$

### Problem of the farm household

The problem of the household is to make market participation decision and the level of production of crops in order to maximise its utility over the consumption of a set of goods produced and bought from the market. So, the optimisation problem of the household choice can be represented as follows:

$$\underset{M_{cb}, M_{cs}, Q_c, x, A_c}{Max} U(Q_c, x), \text{ Subject to}$$

Cash constraint

$$P_x x + \sum_{c=1}^C M_{cb} P_c^* Q_c = Y + \sum_{c=1}^C M_{cs} P_c^* f_c(A_c, I_c, G) \quad (3.1)$$

Constraints of availability of non-tradable factors (labour and land)

$$A = \sum_{c=1}^C A_c \quad (3.2)$$

Constraint of market participation

$$f_c(A_c, I_c, G) \geq Q_c(1 - M_{cb}) \quad \forall c = 1, \dots, C \quad (3.3)$$

Market supply

$$NS_c = f_c(A_c, G, I) - Q_c \quad (3.4)$$

The third constraint (3.3) states that for a household to be self-sufficient or seller of a given crop  $c$  (i.e.  $M_{cb} = 0$ ), its production level must be at least equal to its consumption level. If the production is equal to (respectively greater than) the quantity consumed by the household, the net sale is zero (respectively positive). On the contrary if the household is net buyer of crop  $c$  (i.e.  $M_{cb} = 1$ ), its production may be greater than or equal to zero (this means that, he may produce the crop or not), but this production will be less than the quantity consumed. Solving this model gives the household demand and supply functions that maximise its utility for a given market price and set of household assets.

Because of the dichotomous nature of market participation decision and difference between price received by seller, and paid by buyer households, a procedure in two steps is required in finding the solution of this model, i.e. the production and market participation decisions that maximise household utility (Barrett, 2008). Thus, conditional on each feasible combination of  $M_{cs}$  and  $M_{cb}$ , the first step consists of finding the optimal choice of quantity consumed in agricultural commodities and other tradable goods, the optimal allocation of private assets for production  $\{Q_c, x, A_c\}$  and computing the associated utilities. The second step consists of identifying the market participation vector  $\{M_{cs}, M_{cb}\}$  that maximises household's welfare.

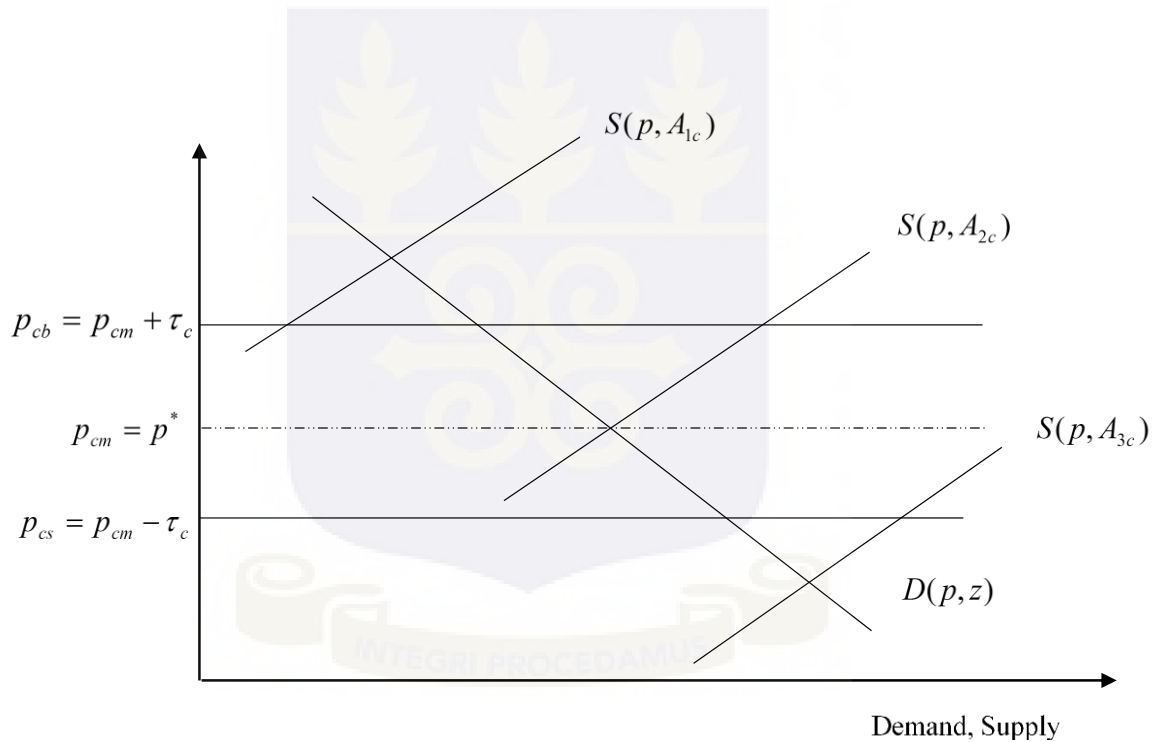
Therefore, for each position of household vis-à-vis the market, the following general formula of market supply and demand functions can be respectively obtained:

$$S = S(p, A) \tag{3.5}$$

$$D = D(p, A) \tag{3.6}$$

Figure 3.2 presents supply functions of three households (net buyer, autarkic and seller household) in the presence of transaction costs. It shows how the difference in households' productive resource and the level of transaction costs explained the difference in their market participation and intensity of commercialisation.

**Figure 3.2: Farm Household Output Demand and Supply in the Presence of Transaction Costs**



Source: De Janvry & Sadoulet (1993)

For simplicity, demand function  $D(p, z)$  is assumed to be identical across households and depends on the price of crop and the socio-economic characteristics of the household. The supply function of each household is differently specified and depends on their own

productive assets (e.g.: land) and price. Thus, farm households' market participation decision depends on the relative position of demand and supply functions (Figure 3.2). In addition, because output market is characterised by the presence of transaction costs, there is a price band within which market participation is not profitable for farmers. Thus, in the presence of transaction costs  $\tau$  in output market, the price  $P_{cm} - \tau_c(\cdot)$  effectively received by the seller and the price  $P_{cm} + \tau_c(\cdot)$  paid by the buyer are different from the market price  $P_{cm}$ . Thus, between the band  $P_{cm} - \tau_c(\cdot)$  and  $P_{cm} + \tau_c(\cdot)$  representing the magnitude of transaction costs, market participation is not profitable for the household and the optimal solution is to adjust its production to its consumption need. This means that within this band, household supply is inelastic to market price, unless price change is sufficiently high to at least cover the transaction costs of market participation. For instance, considering the household 2 with a supply function  $S(p, A_{2c})$  the optimal solution consists of remaining autarkic where its internal equilibrium defines the shadow price at  $p^*$ . This shadow price which is specific to each household is explained by the difference in household resource endowment and the level of transaction costs. For the household with the supply function  $S(p, A_{3c})$ , the internal equilibrium is established below the price band. Thus, by participating in the market as sellers, this household would effectively receive the price  $p_c = p_{cm} - \tau_c(\cdot)$  which is still greater than its internal shadow price.

### **3.3.2. Empirical Method**

This section provides the empirical method for analysing the determinants of smallholders' market participation and the intensity of crop supply, corresponding to the first objective of the study.

#### **3.3.2.1. The Choice of Double Hurdle Model**

The challenge of estimating the determinants of agricultural commercialisation of farm households resides in the fact that there is a huge number of households who live in full subsistence farming and do not report a positive amount of sale of outputs. In this case, a selection problem may arise and the OLS regression of the intensity of sale would lead to biased parameters because farmers who report zero sale will not be included in the estimation. An empirical model that deals with this issue is thus needed to estimate unbiased parameters. Heckman, Tobit and double hurdle models are generally used in these cases. Heckman selection approach corrects the selection bias by first estimating a Probit model of participation and then predicting the Inverse of Mill Ratio (IMR) to be included in the estimation of outcome equation (i.e. the proportion of crop sold). For Heckman procedure to be valid, the coefficient of IMR in the outcome equation must be statistically significantly different from zero (Cameron & Trivedi, 2005). However, the Heckman approach is more suitable for incidental truncation where the zeros represent unobserved values, such as in the case of wage rate models where the sample includes unemployed persons (Heckman, 1979). This means that the use of Heckman regression in the case of agricultural market participation implicitly assumes that the zero observations are the consequence of prohibitive transaction costs that prevent households from engaging in commercial farming (Alene et

al., 2008) but not necessarily a rational choice. Several empirical findings have supported this view that the high transaction costs in rural markets represent a key barrier to market participation. However, in the context of subsistence farming, the choice of households to participate in the markets or not can also be seen as rational choice as regards to household aversion to risks and its capability to produce a marketable surplus. In other words, some households are not only constrained by transaction costs, but also by a limited capacity to produce for markets. Therefore, the zeros observation can be an optimal choice of farm households that are unable to produce substantial market surplus and a corner solution model would be more appropriate than selection model.

The Tobit model, which is a corner solution model, can then be used to analyse household participation in crop markets. In this approach, the zero observation is considered as an outcome of farmer's rational choice (Wooldridge, 2001). This means that the volume of sale  $y_i$  can be expressed as  $y_i = \max(y_i^*, 0)$ . The standard Tobit model is defined as follows:

$$y_i^* = x_i\beta + \varepsilon_i \quad (3.7)$$

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases} \quad (3.8)$$

$y_i^*$  denotes the latent variable representing the intensity of crops sold by household  $i$ .  $y_i^*$  is observed only if it is strictly positive.  $\varepsilon_i$  represents the error term assumed to be homoscedastic and normally distributed (i.e.  $\varepsilon_i \sim N(0, \sigma^2)$ ) for  $i = 1, \dots, n$ . The standard

Tobit model is estimated by maximising the following likelihood function:

$$L(y | x) = [1 - \Phi(x\beta)]^{1(y=0)} \left[ (2\pi)^{-1/2} \sigma^{-1} \exp\left\{-\frac{(y - x\beta)^2}{2\sigma^2}\right\} \right]^{1(y>0)} \quad (3.9)$$

$\Phi(\cdot)$  represents the standard normal distribution function.

However, the limit of Tobit model resides the fact that it is very restrictive. The Tobit model requires that the households' market participation decision and intensity of sale be determined by the same process. In other words, the variables affecting participation decision and the volume of trade must be similar as well as the sense of their effect on both decisions.

However, as previously discussed in the literature review, in agricultural markets some factors such as fixed transaction costs can have a significant effects on the participation decision but not necessarily on the decision about how much to sell (Alene *et al.*, 2008; Goetz, 1992; Key *et al.*, 2000). Therefore, a double hurdle model that is more flexible would be more appropriate.

The Double Hurdle Model (DHM) is originally proposed by Cragg (1971). This model is also a corner solution outcome, but more flexible and represents a generalisation of Tobit Model. In fact, the double-hurdle approach does not require the assumption that the participation and the intensity of participation be determined by the same process as it is the case in Tobit model (Burke *et al.*, 2015). It therefore provides a useful framework to examine separately the effects of variables on participation and the quantity sold. This generalisation of the Tobit model has become increasingly popular in empirical analysis. For instance, Holloway & Barrett (2005) used a Bayesian estimation of double hurdle model to explain farmer participation in milk market in Ethiopia. Croppenstedt *et al.* (2003) applied the DHM to fertiliser use in Ethiopia. Similarly, the crowding out effect of fertiliser subsidies in Malawi has been analysed by Ricker-Gilbert *et al.* (2011) with this model.

### 3.3.2.2. Specification of Double Hurdle Model

The double hurdle model considers that each household has to overcome two hurdles in the marketing decision making process and specifies for each step of decision a corresponding equation. The first equation specifies the decision to participate or not in the agricultural markets while the second one refers to the equation of the intensity of crop sale. Thus, a household decision to participate in crop market and quantity traded can be written as follows:

Decision equation:

$$d_i^* = z_i \delta + \mu_i \quad (3.10)$$

Where  $d_i^*$  is a latent variable indicator of household market participation and  $\mu_i \sim N(0,1)$

$$d_i = \begin{cases} 1 & \text{if } d_i^* > 0 \\ 0 & \text{if } d_i^* \leq 0 \end{cases} \quad (3.11)$$

$d_i = 1$  if the household  $i$  effectively participates in the market of crops as sellers and  $d_i = 0$  if household  $i$  does not sell in the market. Conditional to market participation decision in (3.11), the intensity of crop sold by a given farm household can be expressed as follows:

$$y_i^* = x_i \beta + \varepsilon_i \quad (3.12)$$

With  $\varepsilon_i \sim N(0, \sigma^2)$

Where  $z_i$  and  $x_i$  are vectors of observed explanatory variables that explain respectively household's decision to participate in the market and the intensity of sale.  $\delta$  and  $\beta$  are vectors of parameters to be estimated.  $\mu_i$  and  $\varepsilon_i$  are the error terms. In this model, the positive quantity sold is observed only if household participates in crop market and zero if otherwise. Hence, from (3.10) and (3.11) the observed quantity sold related to latent sale  $y_i^*$  is:

$$y_i = \begin{cases} y_i^* & \text{if } d_i = 1 \text{ and } y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (3.13)$$

The zero observation ( $(d_i = 0)$  and  $(y_i^* = 0)$ ) represents the households that do not participate in the market and therefore, sell no crops. This may be because the current market conditions do not generate a profitable outcome for them or because a marketable surplus has not been generated. It may also include infrequency of sale (Jones & Yen, 2000) which is common in the case of smallholder farmers where their activity is mainly devoted to home consumption.

### 3.3.2.3. Estimation Strategy and Derivation of Average Partial Effects

The original specification of Cragg (1971)'s model that is adopted in this study assumed an independence between the error terms of the two hurdles. Several studies argued that relaxing this hypothesis and assuming a dependence between the error terms does not even provide significant difference in the estimates (Ricker-Gilbert *et al.*, 2011). Thus, if the error terms  $\mu_i$  and  $\varepsilon_i$  are normally, independently and identically distributed (NIID), we have

$$\begin{pmatrix} \mu_i \\ \varepsilon_i \end{pmatrix} \sim N \left[ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix} \right] \quad (3.14)$$

The maximum likelihood estimator can be obtained by Probit regression for the first step of the model (Equation 3.10 and 3.11) and truncated normal regression for the second step (Equation 3.12 and 3.13). The likelihood function of the DHM under the assumption of independence of error terms can be expressed according to Cragg (1971) as follows:

$$L(d, y | x, z) = [1 - \Phi(z\delta)]^{1(d=0)} \left[ \Phi(z\delta) (2\pi)^{-1/2} \sigma^{-1} \exp\left\{-\frac{(y - x\beta)^2}{2\sigma^2}\right\} / \Phi(x\beta / \sigma) \right]^{1(d=1)} \quad (3.14)$$

Thus, the standard Tobit model (Equation (3.7) and (3.8)) is a nested version of Cragg (1971)'s DHM model. If  $z = x$  and  $\delta = \beta / \sigma$ , then the two models become identical, that is, the likelihood of the Tobit model becomes equal to that of the DHM.

For the economic interpretation of limited dependent variable models, it is useful to derive the marginal effect of regressors on the expected value of  $y$ . Three marginal effects of independent variables on the expected value of  $y$  (household commercialisation level) can be derived from the DHM: i) the effects of independent variables  $x_j$  on the probability of participation, ii) the conditional marginal effects and iii) the unconditional marginal effects of independent variables on the expected value of sale. However, for each explanatory variable, the unconditional marginal effect (or average partial effects) will be estimated. It represents the change in the average intensity of crop sale in the sample with respect to one unit change in a given variables  $x_j$ . Thus, following Burke (2009), the unconditional

expectation value of  $y_i$ , denoting the overall average of the intensity of sale can be written as:

$$E(y_i | z_i, x_i) = \Phi(z\delta)[x\beta + \sigma\lambda(x\beta/\sigma)] \quad (3.15)$$

Then, from (3.15), the Average Partial Effect (APE) of a given explanatory variable  $x_j$  which is the marginal effect on the unconditional expected value of  $y$  is expressed as (assuming that  $x_j$  is included in both vectors of  $z$  and  $x$ ):

$$\frac{\partial E(y | z, x)}{\partial x_j} = \delta_j \phi(z\delta)[x\beta + \sigma\lambda(x\beta/\sigma)] + \Phi(z\delta) \beta_j [1 - \lambda(x\beta/\sigma)\{x\beta/\sigma + \lambda(x\beta/\sigma)\}] \quad \text{if} \\ x_j \in x, z \quad (3.16)$$

Where  $\lambda(c) = \phi(c)/\Phi(c)$  represents the Inverse of Mills Ratio (IMR) and  $\phi(\cdot)$  the normal density function.

The estimation procedure described in Burke (2009) will be used to estimate this model. This procedure allows the joint estimation of the first and second stages of the DHM (Equation 3.10 and 3.12 respectively) and then computes the unconditional APEs (Equation 3.16). Finally, the standard errors of the APEs will be estimated by bootstrapping with 100 replications. Thus, based on the estimation results of this empirical model, the following hypothesis are tested:

- *Hypothesis 1:* The likelihood of market participation and the intensity of crop sale increase with the level of farm households' productive resources.

- *Hypothesis 2:* Transaction costs factors such as long distance to market, poor quality of rural roads and access to information affect the likelihood of market participation and the intensity of crop sale.

#### 3.3.2.4. Definition of Variables in the Model

##### *Measuring the Level of Farm Households' Agricultural Commercialisation*

Let  $y_i$  represent the intensity of household participation in agricultural output markets (or agricultural commercialisation). The most frequently used method of measuring agricultural commercialisation in the literature is the proportion of value of crop sold with respect to the value of crop harvested (Govere & Jayne, 2003; Govere et al., 1999; Ochieng et al., 2016; Rios et al., 2009; Von Braun, 1995). This index, referred to as Household Crop Commercialisation Index (CCI) measures the intensity of farm households' participation in output markets. It can be expressed as follow:

$$CCI_i = \frac{\sum_{k=1}^K \bar{P}_k S_{ki}}{\sum_{k=1}^K \bar{P}_k Q_{ki}} * 100 \quad (3.17)$$

Where  $\bar{P}_k$  denotes the market price of the crop  $k$ ,  $S_{ki}$  and  $Q_{ki}$  represent respectively the quantity sold and harvested of crop  $k$  by household  $i$ . It attempts to measure the degree of households' market participation in the scale neutral manner independently to households' wealth and productivity. The advantage of using these approaches is also that it avoids the

crude distinctions between commercialised and non-commercialised households<sup>4</sup> and can take any value from zero (total subsistence-oriented production: no crop sold) to hundred (all crops produced are sold).

In addition, if  $CSI_j$  denotes a given crop  $j$  specific commercialisation index;  $Q_{ji}$  and  $S_{ji}$  the quantity of crop  $j$  produced and sold by the household  $i$  respectively, then the Crop-Specific Commercialisation Index can be formulated as follow:

$$CSI_j = \frac{\sum_{i=1}^N S_{ji}}{\sum_{i=1}^N Q_{ji}} \quad (3.18)$$

$CSI_j$  will tend to one if the crop  $j$  is essentially produced for market while for those meant for consumption  $CSI_j$  will have values closer to zero.

This study focuses on rain-fed crop commercialisation. Therefore, livestock and non-rain fed crops such as vegetables and fruits are not included in the computation of commercialisation index. Household commercialisation index of food crops and Commercialisation Index of overall agricultural output are computed. Using these two indexes, two regressions will be estimated: (i) the first one on the participation of farmers in food crop markets and (ii) the second one concerning the commercialisation of overall agricultural output produced by farm households. For the computation of food crop commercialisation index, the main food crops

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<sup>4</sup> Other indicators of agricultural commercialisation at input side include the proportion of value of purchase input with respect to agricultural income (or value of total input use).

produced and consumed in Burkina Faso that are sorghum, millet and maize are retained. In the second regression, the crops included in the computation of overall crop commercialisation are Maize, Sorghum, Millet, Cotton, Rice, Groundnut, Peanut, Voandzou and Sesame. Thus, the study limits the agricultural output to rain-fed annual crops that encompass cereals and traditional cash crops in order to reduce the heterogeneity of crops in the computation of the index. The statistics presented in Chapter Four provide more description of these crops in the Crop Commercialisation Index.

The choice of regressors in the model is based on the theoretical framework and previous empirical studies. These regressors include the characteristics of households, their productive asset endowment such as land, community characteristics as well as variables of market access and availability of public service (Table 3.1).

**Transaction costs and market access variables:** Market access is generally captured in empirical studies by transportation costs, travel time, quality of rural roads, distance to nearest markets, roads or cities and other transaction costs (Chamberlin & Jayne, 2013). Following Alene *et al.* (2008); Burke *et al.* (2015); Goetz (1992) and Renkow *et al.* (2004) transportation conditions, information access and remoteness are used as indicators of market accessibility. Therefore, Ownership of communication equipment (radio, phone or TV) is used to capture household access to information, while quality of rural roads (measured as a binary variable indicating the existence or not of all-weather roads that link the village to urban areas), distance to market and ownership of transportation assets reflect transportation condition. These variables will be included in both equations. An improved market access is expected to increase the likelihood of participation and the intensity of sale.

**Household productive assets and socio economic characteristics:** Household productive resources are captured in the model by land endowment as measured by the farm size per adult, use of animal traction and the amount of fertiliser use per hectare. These variables are expected to affect positively both participation and intensity of participation decision. In addition, household socio economic characteristics include age, gender and education level of household head as well as household dependency ratio.

**Table 3.1: Definition of Variables and Expected Signs of Market Participation Model**

Household characteristics	Measurement	Expected signs	
		Equation of Participation	Intensity of sale
Gender of household head	Binary (1 if man)	+/-	+/-
Education of household head	Number of years of formal education	+	+
Age of household head	Number of years	+/-	+/-
Dependency ratio	Dependents/active members	-	-
Use of animal traction	Binary (1=yes)	+	+
Livestock ownership	TLU	+	+
Farm size per adult	Hectare	+	+
Distance to nearest market	Kilometre	-	-
Quality of rural roads	Binary (1 if all-weather road links the village to nearest city)	+	+
Nonfarm activities	Binary (1 if household head is engaged in nonfarm activities)	-/+	+/-
Average Cereal price	CFA/kg	+	+
Access to credit	Binary (1 if household head has access to credit)	+	+
Fertiliser used per ha of land	Kilogramme	+	+
Ownership of transportation equipment	Binary (1 if the household owns motorbike or car)	+	+
Ownership of radio/TV/phone	Binary (1 if the household owns phone/radio or TV)	+	+
Agro-climatic zone	Binary (1=South-Sudan zone)	+/-	+/-

Control variables include, credit access, engagement in non-farm activity, livestock ownership, the average price of cereal in the village and a dummy indicating the climate

zone. Burkina Faso is divided into three climatic zones depending on the level of annual rainfall. The Sahel zone with an annual rainfall of less than 600 mm is located in the extreme North. The Sahel-Sudan zone with annual rainfall between 600mm and 900 mm includes the Central and Northern Regions and the South-Sudan zone with annual rainfall above 900 mm includes the Western and Southern parts of the countries (Appendix E illustrates the climate zone in Burkina). However, as households located in the Sahel zone are few in the sample, the binary variable of agro-climatic condition will take the value 1 if household is located in the South-Sudan zone and 0 otherwise, (that is in the Sahel or Sahel-Sudan zone).

### **3.4. Agricultural Commercialisation and Farm Households' Welfare**

#### **3.4.1. Theoretical Framework**

Following Minten & Barrett (2008), a partial equilibrium model is presented to highlight the role of commercial orientation of farm households, technological change and food crop productivity in alleviating rural poverty. Thus, the model defines two types of households in rural areas. The first group includes farmers with productive asset endowment (land and livestock) who generally generate positive marketable surplus. As net food sellers, the income of this group of farmers heavily depends on the level of productivity and market price. The second group concerns farmers with limited assets who do not produce enough food for their own consumption. This group may include rural landless, those employed in nonfarm sector or unskilled labour who draw an important part of their income from agricultural wages (off-farm).

Let  $V(P_j, y)$  denote the indirect utility of a representative household, with  $p_j$  and  $y$  representing respectively the price of food crops and household income; and let  $Q_j = Af(T, L^f, X | Z)$  be the production function of food crops where  $A$ ,  $T$  and  $L^f$  represent respectively, the Hicks-neutral coefficient that captures the productivity of the production technology  $f(\cdot)$ , household farm size and the quantity of labour allocated to crop production.  $X$  represents other factors used in the production and  $Z$  the environmental and ecological conditions under which production is undertaken. A higher level of  $A$  implies a greater agricultural output per unit of land  $T$  or per unit of labour employed  $L^f$  given the underlying environment condition,  $Z$ . The production function is assumed to be monotonic and concave. Thus, an improved production technology  $A$  will lead to increase in agricultural output  $Q_j$  especially for land owners  $T > 0$  in adequate environmental condition  $Z > 0$  and allocating labour to crop production  $L^f > 0$ . Household income  $y$  can be decomposed into farm and non-farm income as follows:

$$y = p_j Af(T, L^f, X | Z) + w(L - L^f) \quad (3.19)$$

In addition, the price  $p_j$  can be expressed in terms of inverse demand function as:

$$p_j = p_j(Q_j) \quad (3.120)$$

Let  $w$  represent the prevailing wage rate of unskilled labour and  $L$  the total stock of available labour. As net buyers and net sellers of food crops coexist in rural areas, the change in market price of food crops does not have a homogenous effect on farm households. In general, productivity growth due to technological change affects rural households' welfare

through market price, wage and directly through income gained from commercialisation of farm produce while increasing the availability of food for households. Thus, the effect of technological change on welfare via price variation is obtained by totally differentiating  $p_j$  expressed in Equation (3.20) with respect to  $A$  as follow:

$$\frac{dp_j}{dA} = \frac{dp_j}{dQ_j} \cdot \frac{dQ_j}{dA} \quad (3.21)$$

The effect of technological change on price  $\left(\frac{dp_j}{dA}\right)$  depends on the magnitude of price change with respect to variation in production level  $\left(\frac{dp}{dQ}\right)$  and the magnitude of production change due to technological innovation  $\left(\frac{dQ}{dA}\right)$ . A technological innovation will increase the level of output, i.e.  $\frac{dQ}{dA} > 0$ . In addition, since household demand curve is negatively sloped, then we have  $\left(\frac{dp}{dQ} < 0\right)$ . Therefore,  $\frac{dp_j}{dA} < 0$  which means that adoption of improved technology will decrease output price that is favourable to net buyers of food crops. However, the magnitude of price reduction will depend on price elasticity of food crop demand. Furthermore, to obtain the overall effect of productivity on household income/welfare, Equation (3.19) is differentiated and divided by  $dA$ :

$$dy = dp_j \cdot Q_j + p_j \cdot dQ_j - w \cdot dL^f + dw \cdot (L - L^f) \quad (3.22)$$

$$dy/dA = \left[ \frac{dp_j}{dA} \cdot Q_j + \frac{dQ_j}{dA} \cdot p_j - \frac{dL^f}{dA} \cdot w \right] + \left[ \frac{dw}{dA} \cdot (L - L^f) \right] \quad (3.23)$$

This equation can be modified using the elasticity of technology change (Dzanku, 2015b).

Then, we have:

$$\frac{dy}{dA} = \left( \frac{p_j \cdot Q_j}{A} \cdot \varepsilon_{p_j, A} + \frac{P_j \cdot Q_j}{A} \cdot \varepsilon_{Q_j, A} - \frac{w \cdot L^f}{A} \cdot \varepsilon_{L^f, A} \right) + \left( \frac{w \cdot (L - L^f)}{A} \cdot \varepsilon_{w, A} \right) \quad (3.24)$$

With  $\varepsilon_{p_j, A}$  the elasticity of market price with respect to technological change,  $\varepsilon_{Q_j, A}$  the elasticity of quantity of food crop produced with respect to technological change,  $\varepsilon_{L^f, A}$  the elasticity of quantity of labour allocated to crop production with respect to technological change and  $\varepsilon_{w, A}$ , elasticity of the level of wage with respect to technological change. The effect of productivity growth on household welfare depends on the sign and the magnitude of these elasticities. In addition, the welfare effect may be different according to household net position in the market and its level of engagement in off-farm activities. The first three terms of Equation (3.24),  $\left( \frac{p_j \cdot Q_j}{A} \cdot \varepsilon_{p_j, A} + \frac{P_j \cdot Q_j}{A} \cdot \varepsilon_{Q_j, A} - \frac{w \cdot L^f}{A} \cdot \varepsilon_{L^f, A} \right)$  represent the effect of increase in productivity on income of net food crop seller households. For this group, the net effect of agricultural productivity growth on crop income is positive if and only if the absolute value of elasticity of output with respect to technological change  $\varepsilon_{Q_j, A}$ , which is positive, is greater than the elasticity of price with respect to technical change  $\varepsilon_{p_j, A}$  which is negative  $\left( \varepsilon_{Q_j, A} > \left| \varepsilon_{p_j, A} \right| \right)$ . However,  $\varepsilon_{p_j, A}$  depends on the size of market that the farmers have

access to. The more the crop is marketable and the various markets are more accessible to farmers, especially in urban areas, the less the price effect would be compared to the productivity increase effect and then the net sellers will experience a greater income. However, when markets are highly segmented, crop price will be highly sensitive to local productivity increase and  $\left| \varepsilon_{p_j,A} \right|$  will tend to be greater than  $\varepsilon_{q_j,A}$  and may at least in the short run decrease income of net food sellers.

The last term of the equation  $\left( \frac{w \cdot (L - L^f)}{A} \cdot \varepsilon_{w,A} \right)$  represents the income change of households who are engaged in off-farm work. Minten & Barrett (2008) argue that it is likely that  $\varepsilon_{w,A} > 0$ . This is because technological change in agriculture would have a positive effect on the dynamic of rural nonfarm activities and lead to increase in the wage rate.

Thus, this model shows that increase in farm productivity through technological change directly induces greater market supply and income for net sellers, and indirectly would also improve welfare of rural workers through price reduction and increase in real wage. In particular, if market access is less costly and price relatively stable, the opportunity for profit is higher and may stimulate production and commercialisation.

### 3.4.2. Empirical Methods

This section presents the empirical methods for the last two objectives of the study. The first one concerns the effect of agricultural commercialisation on food crop productivity and input use and the second objective concerns the poverty reduction effect of agricultural commercialisation.

### 3.4.2.1. Assessing the Effects of Agricultural Commercialisation on Input Use and Food Crop Productivity

The empirical models for analysing the effect of agricultural commercialisation on input use and productivity (objective 2) is developed in this sub-section. A Tobit and instrumental variable models are respectively used to estimate the effect of agricultural commercialisation on fertiliser use and on food crop productivity.

#### 3.4.2.1.1. Agricultural Commercialisation and Fertiliser Use: A Tobit Model

This study restricts the technological change effect to fertiliser use by farmers because of the lack of data on others form of modern technologies use such as adoption of improved seeds. Thus, to analyse the effect of farm households' market participation on fertiliser use, a similar model specified by Strasberg *et al.* (1999) is estimated. Thus, the model of fertiliser use is expressed as:

$$fert_i = \alpha_0 + \alpha_1 CCI_i + \alpha_2 X_{li} + v_i \quad (3.25)$$

Where  $fert_i$  is the quantity of fertiliser use by farm household  $i$  per hectare of land under cultivation;  $CCI_i$  represents the overall Crop Commercialisation Index of farm household;  $\alpha_j$  denote parameters to be estimated and  $v_i$  the error term.  $X_{li}$  is a vector of other variables likely to influence the use of fertiliser by farm households.

Data on fertiliser used are censored because several farm households in the sample do not use fertiliser in their production system. Thus, it can be distinguished farm households with

positive quantity of fertiliser use with households that did not use fertiliser and present a zero values. Therefore, a censored model is more appropriate to estimate the parameters of the equation. A Tobit regression method with zero as a lower bound will then be applied in order to take into account this issue. Tobit model has already been described in the previous section (namely in section 3.3.2.1).

#### *Choice of Explanatory Variables*

Aside the variable of crop commercialisation index, numerous variables are likely to influence the adoption of fertiliser. It is often argued that liquidity constraints represent one of the key factors of low use of improved technologies in developing countries. Therefore, the amount of credit received for agricultural activities and nonfarm income earned will be included as explanatory variables. These variables are expected to yield positive signs on the intensity of fertiliser use. Accessibility to markets would also influence farm households' access to fertiliser. Thus, increase in distance to nearest market may reduce the intensity of fertiliser use while holding transportation assets and existence of all-weather roads would have a reverse effect. Thus, the total value of households' transportation assets evaluated by the household head at the time of survey is included (See Appendix A). Furthermore, holding communication equipment may be a source of access to information on best agricultural practice and influence fertiliser use. Therefore, a dummy variable taking the value 1 if household head owns a communication assets (radio, TV, or phone) and 0 if not will be included. Finally, age and education level of household head are included to control for the influence of household characteristics on intensity of fertiliser use. All the explanatory

variables included in the model, their unit of measurement and expected signs are presented in Table 3.2.

**Table 3.2: Definition of Variables and Expected Signs of Model of Fertiliser Use**

<b>Explanatory variables</b>	<b>Measurement</b>	<b>Expected signs</b>
Crop commercialisation index	Percentage (%)	+
Value of transportation asset	10,000 FCFA	+
Agricultural credit received	10,000 FCFA	+
Nonfarm income per adult	10,000 FCFA	+/-
Distance to nearest markets	Kilometre	-
Existence of all-weather road	Binary (1=yes)	+
Communication asset	Binary (1=yes)	+
Age of household head	Years	+/-
Education level of household	- Reference: No education - 1. Primary - 2. Secondary	+
Climate zonal dummy	Binary (1=South-Sudan zone)	+

#### **3.4.2.1.2. Agricultural Commercialisation and Farm Productivity: Instrumental Variable Regression**

This section develops the model for analysing the direct effect of agricultural commercialisation on farm productivity. A general formula of the productivity model can be expressed as follows:

$$y_i = f(CCI, X, D; \beta) + \varepsilon_i \quad (3.26)$$

Where  $X$  represents a vector of production factors including household dependency ratio, farm size per worker, livestock ownership and the quantity of fertiliser use per hectare and a set of other variables that are likely to influence crop yield. These variables include the age, gender and education level of household head. The variable ‘education’ used in this

regression is categorised in three levels: No formal education (use as reference), primary level of education and finally secondary level. Thus, no education is used as basis of comparison and therefore does not appear in the estimation results.  $D$  represents a vector of dummy variables including participation or not in nonfarm activities by household head, adoption of soil conservation techniques and location characteristics (agro-climatic condition). In Burkina Faso, several farm households are facing high degradation of their land due to hardship of climate condition particularly drought. To control the effects of these shocks on their production, they adopt some techniques to retain water on their field and reduce soil erosion<sup>5</sup>. Adoption of these techniques is expected to have direct positive effect on the level of productivity. Thus, the productivity model is specified as follow:

$$\log(y_i) = \beta_0 + \beta_1 CCI_i + \sum_{j=2}^J \beta_j \log(x_{ji}) + \delta D + \varepsilon_i \quad (3.27)$$

Where  $CCI_i$  represents the crop commercialisation index of the household  $i$  and  $\beta_k$  are vectors of unknown parameters to be estimated and  $\varepsilon_i$  the error terms.

#### *Measurement of food crop productivity*

The dependent variable  $y_i$  represents the yield per hectare of food crops produced by household  $i$ . Food crops that are used in the computation of yield include maize, sorghum and millet. They represent the most important staple crops produced by smallholder farmers

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<sup>5</sup> The common techniques used and identified in the survey include “Zaï”, Diguettes or cordon pierreux, Demi-Lune, Haies vives. The variable, adoption of soil conservation techniques takes a value one if the farmer adopts any one of these techniques.

in Burkina Faso. In numerous studies, the value of crops per hectare is used as measure of yield. This study, following Carter (1997), adopts instead a weighted measure of output to compute farm yield per hectare in sorghum equivalent. Based on the market price of the different crops, maize and millet are converted into sorghum equivalent. The quantity of crop  $i$  is converted into sorghum equivalent (SE) according to the following formula:

$$SE_i = \frac{\bar{P}_i}{P_s} * Crop_i \quad (3.28)$$

Where  $Crop_i$  denotes the quantity of crop  $i$  (in kg),  $\bar{P}_i$  the price of crop  $i$  and  $P_s$  the price of sorghum at village level. Therefore, food crop yield is computed as:

$$y_i = \frac{sorghum + \sum_i SE_i}{land} \quad (3.29)$$

Where  $sorghum$  indicates the quantity in kilogrammes of sorghum produced by the farmer and  $land$  the total land size in hectare devoted to the production of food crops.

#### *Estimation Strategy: Instrumental Variable Approach*

Previous empirical studies have stressed that household crop commercialisation index is likely to be endogenous in agricultural productivity model (Rios et al., 2009). The problem of endogeneity is generally related to the omission of relevant explanatory variables, measurement errors or problem of simultaneity between the dependent variable and explanatory variables (Wooldridge, 2001). The latter seems to particularly characterise the endogeneity issue in this model because some variables such as household asset endowment

and agro-climatic condition may affect both productivity and the level of household commercialisation. As argued by Barrett (2008), households' decision to use modern inputs to increase productivity and the quantity of market supply depend both on the opportunity of profit offered by the markets but also on the level of households' assets. Thus, this may cause a problem of simultaneity and failing to correct it would lead to inconsistent estimation of the impact of commercial farming on food crop productivity. To solve this issue of endogeneity this model will be estimated using the instrumental variable approach as adopted by (Govere, Jayne, and Nyoro 1999; Govere & Jayne 2003) <sup>6</sup>.

#### *Choosing the Instrumental Variables*

The correction of endogeneity bias by instrumental variable regression methods, requires finding instruments that affect productivity only indirectly through their effect on farm households' market participation. Rios *et al.*, (2009) in a similar work used ethnic group that the household belong to, ownership of transportation equipment, and road accessibility as instrumental variables. The assumption is that these variables facilitate crop sale in that belonging to the same tribe facilitates cooperation and communication while owning of transportation asset and quality of roads reduce marginal cost of movement. In this study, the selected instruments include distance to nearest market, population in the village, household's ownership of communication equipment and household's market orientation index. The distance to nearest market increases transaction costs and may affect the intensity of households' crop supply. Thus, Households that are closer to market are likely to bear low

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<sup>6</sup>An in-depth discussion on IV regression can be found in Wooldridge (2001b) and Cameron & Trivedi (2005).

costs and thus have more incentive to increase their market participation. In addition, ownership of communication assets and the number of inhabitants in the village may greatly influence the intensity of market supply, but may not have a direct impact on productivity.

Finally, the last instrument used, the index of market orientation, merits some explanations. In fact, it is evident that there is some difference in the level of tradability of crops produced by smallholder farmers. For instance, cotton is more highly marketable than cereals. Among cereal crops, maize is more market oriented than sorghum and millet. Thus, difference in households' level of commercialisation may depend on the extent to which resources such as land, labour and capital are allocated to the commodities that are highly market oriented. However, this cropping pattern per se does not influence cereal yield but would necessarily influence the intensity of households' market participation. In fact household that allocates for instance more land to cotton production which is highly market oriented will necessary result in the increase in its level of commercialisation. However, this allocation of resource does not have a direct effect on the yield of food crop. Therefore, following Gebremedhin & Jaleta (2010), an index of household market orientation is computed and will be used as one of the instruments for crop commercialisation index. For each crop, a crop-specific commercialisation index is first estimated as the ratio of a given crop sold to total quantity of this crop produced by households. Let  $CSI_j$  denote as in Equation (3.18) the crop-specific commercialisation index:

$$CSI_j = \frac{\sum_{i=1}^N S_{ji}}{\sum_{i=1}^N Q_{ji}}; \text{ Where } Q_{ji} \text{ and } S_{ji} \text{ represent respectively the quantity of crop } j \text{ harvested}$$

and sold by the household  $i$ .  $CSI_j$  will tend to one if the crop  $j$  is essentially produced for market while for those mainly produced for consumption  $CSI_j$  will have values that are closer to zero. A more market oriented farm household is then likely to allocate a significant share of its resources to the more commercialised produce in the country. Therefore, using crop-specific commercialisation index, market orientation index is here constructed in terms of household land allocation pattern weighted by the commercialisation index of each crop as follows:

$$MOI_i = \frac{\sum_{j=1}^k CSI_j T_{ji}}{T_i} \quad (3.30)$$

$MOI_i$  represents household market orientation index,  $T_{ji}$  denotes the quantity of land devoted to crop  $j$  and  $T_i$  the total land size of household farms. This index refers to the extent to which households' resource allocation (especially land) is towards more marketed crops. The higher ratio of land the farmer devotes to the more tradable crops, the more market oriented is the household.

Various tests will be conducted to assess the validity and relevance of these instruments that will be used to estimate the model described.

*Testing the Endogeneity of Household Level of Crop Commercialisation*

The issue of OLS versus IV regression is generally discussed using Durbin-Wu-Hausman (DWH) tests. These tests basically consist of estimating the model by OLS and IV and comparing the vector of coefficients obtained through these regressions. The objective is to test whether a variable presumed to be endogenous could be treated as exogenous or not. If the assumed endogenous regressors are revealed as exogenous by the test, then the OLS estimator will be more efficient and there will be no need to adopt IV regression approach. Hausman tests of endogeneity will then be performed to check if the intensity of household level of commercialisation is exogenous.

*Testing the Validity and the Relevance of the Instruments*

The validity and relevance of instruments used are crucial for the quality of the estimation. Valid instrumental variables must satisfy two requirements. Firstly, the vector of instruments  $Z$  (distance to nearest market, population in the village, household's ownership of communication equipment and household's market orientation index) must be strongly correlated with the endogenous variables, that is  $E(CCI_i Z) \neq 0$ . This means that  $Z$  must be statistically different from zero in the first stage regression of  $CCI_i$  on the exogenous variables  $X$  and  $Z$ . Secondly, the instruments must be orthogonal to the error terms  $\varepsilon_i$  in the productivity model in Equation (3.27), that is  $E(Z\varepsilon) = 0$ . The first requirement is called the relevance condition and the second is the exogeneity or validity condition of instruments.

The F-test of excluded instruments and KP LM statistics of weak identification test are used to assess the relevance of the instruments used. Concerning the second condition of

independence between error terms and the instruments, the Hansen's J statistics of over identification of instruments is used to check this requirement. The null hypothesis states that the model is over-identified, meaning that it contains at least as many valid instruments as the number of endogenous variables. Therefore, failing to reject this hypothesis means that the instruments used are valid.

The estimation results of the two specifications (Equations 3.25 and 3.27) will be used to test following hypotheses:

- *Hypothesis 1:* Market participation of smallholder farmers is a key driver of technological change.
- *Hypothesis 2:* There is a positive relationship between agricultural commercialisation and food crop productivity.

### **3.4.2.2. Modelling the Effect of Agricultural Commercialisation on Rural Poverty**

After describing the method used to identify the poor and evaluate the incidence of poverty among households in the sample, this section presents the empirical method for analysing the effects of commercialisation in agriculture and food crop productivity on rural poverty (objective 3 of the study).

#### **3.4.2.2.1. Measuring the Poverty Incidence among Farm Households**

##### *Concept of Poverty and Measurement Issues*

Poverty is a multi-dimensional concept and generally refers to a pronounced deprivation in wellbeing (World Bank, 2005). Economists generally focus on welfarist approach which

analyses households' wellbeing based on their utility level or standard of living<sup>7</sup> (Ravallion, 1992). Thus, in this perspective, Ravallion (1992) stresses that “*poverty* exists in a society if one or more persons do not attain a level of material wellbeing deemed to constitute a reasonable minimum by the standards of that society”. This means that the poor are those suffering from absolute deprivation or unable to enjoy the society’s minimum standard of living to which everyone should be entitled. This study follows this approach and recourses to a money metric method to define household poverty status. However, two key issues need to be considered in measuring households’ wellbeing and defining their poverty status for comparison. The first issue concerns the identification of poor, i.e. how to measure households or individuals’ wellbeing (or utility) and how the reasonable minimum can be set to distinguish poor from non-poor households. The second issue refers to the aggregation of poverty measure, i.e. how to deal with differences in household size and composition in the aggregation process.

Concerning the first issue, because of difficulties of direct measurement, wellbeing of households or individuals is most often defined in terms of their standard of living which is measured either by income or consumption expenditure. However, in developing countries consumption is seen as the better indicator of standard of living than income and this for several reasons (Deaton, 1997). First, current consumption represents a direct measure of standard of living while income is just a proxy of current consumption. In this case, income may not be a good indicator of standard of living when there are important constraints of

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<sup>7</sup> Ravallion (1992) argues that the non-welfarist approach of poverty analyses households’ wellbeing in terms of their right to access to resources. This may also include some aspects such as freedom, etc.

accessibility or availability of some goods rendering their consumption difficult for households. Secondly, income is more variable particularly among farmers in developing countries due to seasonality of agricultural production. Therefore, the level of income recorded will highly depend on the time of survey. Even if a one year income could be recorded to overcome this issue, the recall bias would be so important to affect the quality of the indicator. On the other hand, consumption expenditure is less volatile than income. In fact, households may have consumption smoothing opportunities, albeit informal such as saving and insurance (risk sharing). From this perspective, Ravallion (1992) notes that current consumption may even be a good indicator of long term wellbeing as it will reveal information about income at times past and the future. Therefore, one year consumption expenditure will be used to measure households' wellbeing.

Moreover, without expenditure data some studies suggested an estimation of asset index using principal components analysis to evaluate household wellbeing (Filmer & Pritchett, 2001). Though this indicator provides useful information on household wealth and ability to general income, it does not provide actual information on household standard of living. In addition, as our data provide information on household consumption expenditure, this will be used to directly assess household standard of living.

The measurement of households' wellbeing and then its poverty status can also be restricted to food or extended to non-food aspects. Thus, household is said to be food poor if its food expenditure is below the minimum required to access the basic food necessary for a healthy life. This definition of food poor is also an indicator of household food security. The general definition of poverty will include not only food expenditure, but also non-food expenditure

such as education, healthcare, clothing, etc. Thus, based on this, poor households will refer to those whose total expenditure per capita does not reach the minimum required to satisfy the basic need in terms of food and non-food items.

*Measuring Households' Consumption Expenditure and Identification of Poor Households*

Based on money metric approach of poverty assessment, household total expenditure is used as indicator of wellbeing. Information on households' total expenditure includes food and non-food items all evaluated at market prices. Food expenditure includes basic foods (such as cereals) and high value foods (such as meat, milk, etc.). Non-food expenditure includes education, healthcare, clothing, etc. Households' self-consumed productions (foods and non-foods) are also included in computation of consumption expenditure. This latter component is particularly important in this case of farm households whereby a major share of agricultural production is meant for internal consumption (Details on goods included in the computation of consumption expenditure is provided in appendix A). To reduce the recall bias, a Mix Recall Period (MRP) is used during the data collection. Thus, the questionnaire is designed to record the expenditure on each good according to the frequency of household consumption of that goods. Goods that are not frequently consumed are recorded on 6-months or one-year basis while the expenditure on good consumed frequently are recorded on monthly basis. However, based on the recall period used, all expenditure data is converted into one-year basis and the summation of households' expenditure on the different items represents its total consumption expenditure per year.

Moreover, in order to allow comparison across households, it is useful to account for difference in household size and composition. Therefore, per capita household expenditure

is calculated in adult equivalent using the OECD scale equivalence method. The rationale of the OECD equivalence scale is that consumption need of adults and children are different and therefore, there is a need to be account for. Secondly, there is economy of scale in the expenditure such that if for instance the minimum required per adult is 1USD per day, with two adults living together the minimum would be less than 2USD because of economy of scale. Thus, the OECD equivalence scale is expressed as follow (World Bank, 2005):

$$AE = 1 + 0.7 * (N_{adults} - 1) + 0.5 * N_{children} \quad (3.31)$$

Where  $AE$  denotes household size in adult equivalent,  $N_{adults}$  and  $N_{children}$  the number of adults and children in the household respectively. The nominal total expenditure is then divided by the equivalence scale to obtain per capita household expenditure.

The method of Foster-Greer-Thorbecke (1984) is used to evaluate the incidence of poverty. Thus, the well-known FGT classes of poverty measures is expressed as follows:

$$P_{\alpha} = \frac{1}{N} \sum_{i=1}^H \left[ \frac{z - y_i}{z} \right]^{\alpha} \quad (3.32)$$

Where  $N$  is the number of individuals in the sample,  $z$  the poverty line,  $y_i$  is the per capita consumption of household  $i$ ,  $H$  the number of poor in the sample (i.e. households with consumption expenditure that is below the poverty line  $z$ ) and  $\alpha$  is a parameter of poverty aversion. If  $\alpha = 0$  then,  $P_{\alpha} = H/N$  represents the headcount index or proportion of household being poor in the sample. If  $\alpha = 1$ , then  $P_{\alpha}$  is the poverty gap index, that is a measure of the

depth of poverty or the mean distance between the poor and the poverty line. If  $\alpha = 2$ ,  $P_\alpha$  represents a measure of severity of poverty reflecting the degree of inequality among the poor.

The poverty line  $z$  defined the minimum amount required for an adult to satisfy its basic daily need. In this case,  $z$  represents the minimum level of consumption (or income) required per adult and per year to satisfy its basic needs which include food and non-food goods and services such as education and healthcare, clothing. In Burkina Faso, the national poverty line was estimated at 130,735 FCFA per adult and per year in 2011<sup>8</sup>. Therefore, this poverty line will be used to identify the poor and non-poor households and estimate the different classes of FGT poverty measurement of the sample.

#### **3.4.2.2.2. Specification of the Model and Method of Estimation**

Based on a consumer choice theory, a consumer  $i$  chooses a bundle of goods that maximises the utility function  $U(q)$  subject to a budget constraint  $y_i = p \cdot q$ . At optimal level, if  $U^*$  is the maximum value of utility reached, then  $y_i$  represents necessarily the minimum cost to attain  $U^*$ . Therefore,  $y_i$  denotes the household cost or expenditure function and represents a measure of wellbeing. Thus, including household characteristics in order to capture the differences across households and following Deaton (1997),  $y_i$  can be expressed as:

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<sup>8</sup> This amount represents about 262 USD per adult and per year or 0.71 USD per adult and per day

$$y_i = p \cdot q = e(p, x, U^*) \quad (3.33)$$

Where  $p$  and  $q$  represent respectively the vectors of price and quantity of goods consumed,  $e(\cdot)$  is an expenditure function,  $x$  denotes household characteristics (composition, size, etc.).

Based on this theory, to estimate the extent to which agricultural commercialisation and food crop productivity affect poverty among smallholder farm households, a discrete choice model of household poverty status will be specified. Let  $w_i^*$  be a latent variable representing household unobserved poverty status (or wellbeing) as function of food crop productivity  $yield_i$ , household commercialisation index  $CCI_i$  and a set of exogenous factors  $x_i$ .

$$w_i^* = X_i \beta + \varepsilon_i \quad (3.34)$$

$$w_i^* = \alpha_0 + \alpha_1 CCI_i + \alpha_2 \ln(yield_i) + \alpha_3 \ln(yield_i) * CCI_i + x_i \gamma + \varepsilon_i \quad (3.35)$$

$\alpha$  and  $\gamma$  denote the vectors of unknown parameters to be estimated, and  $\varepsilon_i$  the error terms.

The observed household position as poor or not is described by a discrete variable  $w_i$  taking the value 1 if the household consumption expenditure is below the poverty line  $z$  and zero otherwise. Hence,

$$w_i = 1 \quad \text{if } w_i^* < z \quad \text{and} \quad w_i = 0 \quad \text{Otherwise}$$

Therefore, as regards to the binary nature of poverty indicator, Logit regression model is applied. The Logit model is formulated as follows:

$$p_i = \Pr(w_i^* < z) = \Pr[w_i = 1 | X_i] = \frac{\exp(X_i\beta)}{1 + \exp(X_i\beta)} \quad (3.36)$$

In the literature, coefficient of Logit model are commonly interpreted in terms of marginal effects on the odds ratio rather than on the probability itself. Thus, from (3.36), we can write

$$\frac{p_i}{1-p_i} = \exp(X\beta) \Leftrightarrow \ln\left(\frac{p_i}{1-p_i}\right) = X\beta \quad (3.37)$$

$$\Leftrightarrow \ln\left(\frac{p_i}{1-p_i}\right) = \alpha_0 + \alpha_1 CCI_i + \alpha_2 \ln(\text{yield}_i) + \alpha_3 \ln(\text{yield}_i) * CCI_i + x_i\gamma + \varepsilon_i \quad (3.38)$$

Here,  $p_i$  represents the probability of being poor (i.e.  $w_i = 1$ ). The ratio  $\frac{p_i}{1-p_i}$ , called odds ratio or relative risk measures the probability that  $w_i = 1$  relative to the probability that  $w_i = 0$  (Cameron & Trivedi, 2005). It follows that a one unit increase in a given regressor  $X_j$ , affects the odds ratio (i.e. the relative probability of being poor) by  $\exp(\beta_j)$ , ceterus paribus. Thus, after the estimation of the Logit model, the estimated coefficients of the model and the coefficient of odds ratio are directly reported.

The marginal effect of agricultural commercialisation on the logarithm of odds ratio is:

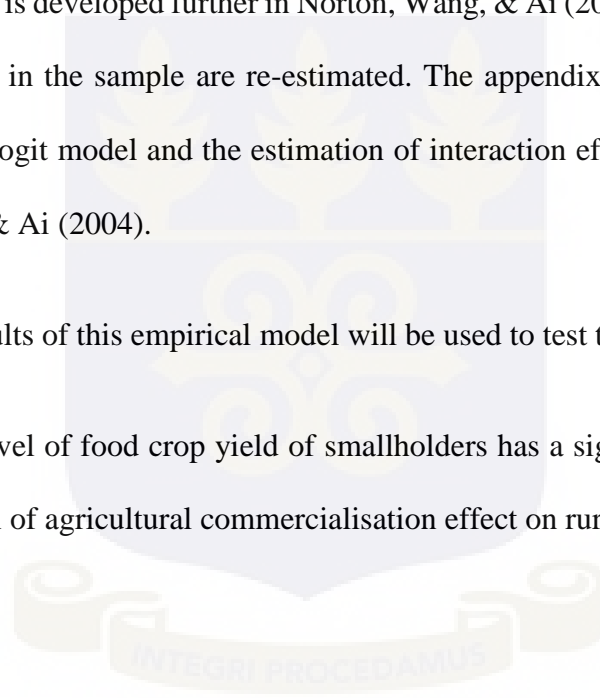
$$\frac{\partial \ln\left(\frac{p_i}{1-p_i}\right)}{\partial CCI_i} = \alpha_i + \alpha_3 \ln(\text{yield}_i) \quad (3.39)$$

In this specification, the overall marginal effect of agricultural commercialisation on households' welfare depends on the level of food crop yield because of the presence of

interaction term between commercialisation index and yield. However, in a nonlinear model, the interaction effect will not be just equal to  $\alpha_3$  and the effect of commercialisation index would be different to  $(\alpha_1 + \alpha_2 \ln(\text{yield}_i))$  as it would be for a case of linear model. Ai & Norton (2003) showed that there is a difference between the magnitude of interaction effect and the marginal effect  $\alpha_3$  of the interaction term in nonlinear model and suggested a method to estimate the marginal effect of interaction term in Logit and Probit model. Thus, following their method which is developed further in Norton, Wang, & Ai (2004), the interaction effect and its distribution in the sample are re-estimated. The appendix D provide the results of estimation of the Logit model and the estimation of interaction effect based on the method of Norton, Wang, & Ai (2004).

The estimation results of this empirical model will be used to test this following hypothesis:

*Hypothesis:* The level of food crop yield of smallholders has a significant influence on the magnitude and sign of agricultural commercialisation effect on rural poverty.



### 3.5. Data Source and Sampling Procedure

#### 3.5.1. Data Source

Data used in this thesis come from a survey undertaken at national level in 2011 by a team<sup>9</sup> of University of Ouaga 2 under the second phase of ‘*Programme National de Gestion des Terroirs*’ (PNGT2)<sup>10</sup>. The PNGT2 is co-financed by the public sector and numerous international institutions including World Bank and IFAD. This project is designed to be implemented into three phases, over 15 years. The first two phases were implemented from 2001 to 2006 and from 2007 to 2013. The third phase was launched in 2013 to cover five year period, 2014-2018. The main objective of the project is “to reduce poverty and promote sustainable development in rural areas, breaking the spiral of rural poverty characterised by natural resource degradation, low productivity and lower level of standard of life.” (FIDA, 2010).

The project initially targeted 2,000 villages in 26 provinces out of the 45 provinces of the country. These villages were chosen based on the degree of natural resource degradation, the low level of rural income and the absence of other development projects. Other criteria for the choice of villages included social cohesion and existence of dynamic rural organisations. According to FIDA (2010), due to significant improvement brought by the project in terms of local governance, access to basic infrastructure and rural poverty reduction, it has been

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<sup>9</sup> The data is collected by LAQAD-S « Laboratoire d’Analyse Quantitative Appliqué au Développement-Sahel » which is an economics laboratory in the department of economics of University of Ouaga 2.

<sup>10</sup> PNGT2 can be understood as ‘Second phase of National Programme of Management of Regions’.

extended to other villages of provinces where the project was implemented and reached over 3000 villages in 2010.

### 3.5.2. Data Collection and Sampling Procedure

The process of sample choice involves two-stages, cluster and randomised sampling approaches. Burkina Faso has 349 communes (or districts) which are grouped into 45 provinces and 13 regions. Within each province, the choice of the villages was done using cluster sampling according to the mode of intervention of the Project. The number of villages per province is also chosen with respect to the representativeness of the province at national and regional levels in order to permit comparison across regions and provinces. Thus, two to seven villages have been selected by province based on a complete list of villages in the provinces making a total of 270 villages. After the choice of villages, the next step consists of the choice of households in the villages to be surveyed. A complete list of households in each village is obtained and stratified according to their ownership and use of animal traction. This stratification is done in order to ensure a representative number of households of each stratum in the sample. Finally, within each stratum, households are randomly sampled. Eight households is selected per village, making the total sample size of 2,160 households distributed across 270 villages of the 13 regions of the country. Table 3.3 presents the distribution of the sample by stratum.

**Table 3.3: Distribution of Sampled Households by Type of Traction Used**

Type of households	Sample size	Frequency (%)
Animal traction	1,235	57.18
Manual traction only	925	42.82
Total sample size	2,160	100.00

A structured questionnaire was designed and submitted to the households in the sample. The questionnaire collected various information on the socio-economic conditions of households including food and non-food expenditure, farm output produced and sold, as well as income from nonfarm activities. In addition, information on community characteristics such as the availability of schools and health facilities and access to other infrastructures (distance to market/paved road/nearest town) as well as market price of crops and other tradable in the nearest market was collected.

However, this study is conducted based on a sample of 1,178 households distributed across the 270 villages. This is because farm households with important missing information are omitted. In addition, only households whose heads are mainly engaged in agriculture but also allocating a part of land for the production of food crops such as sorghum, millet or maize are selected. Table 3.4 presents the distribution of the final sample retained by region and by type of agricultural mechanisation.

**Table 3.4: Distribution of the Selected Sample by Region and Type of Traction Used**

Regions	Manual traction only	Animal traction	Total
1. Boucle du Mouhoun	40	82	122
2. Cascades	21	11	32
3. Centre	4	41	45
4. Centre-East	49	98	147
5. Centre-North	54	66	120
6. Centre-West	87	61	148
7. Centre-South	24	57	81
8. East	27	38	65
9. Hauts-Bassins	32	63	95
10. North	22	100	122
11. Plateau Central	12	68	80
12. Sahel	13	2	15
13. South-West	83	23	106
Total	468	710	1,178

## CHAPTER FOUR

### RESULTS AND DISCUSSION

#### 4.1. Introduction

This chapter presents and discusses the empirical findings of the thesis. The first section presents the descriptive statistics and assesses the intensity of agricultural commercialisation among smallholder farmers. The second section deals with the determinants of smallholders' crop commercialisation in rural Burkina Faso. In the third section, the effect of agricultural commercialisation on input use and food crop productivity is analysed and finally, the fourth section presents and discusses the effect of agricultural commercialisation on rural poverty.

#### 4.2. Descriptive Statistics of the Sample

##### 4.2.1. Socio-Economic Characteristics of the Sample

The average household size of the sample is about 9 individuals and the dependency ratio is 1.5<sup>11</sup>. This means that for every five persons in the household, three are dependents. Households that sell crops have significantly larger household size than those who do not. In addition, 95% of household heads are male with an average age of 48 years. Their education level, measured in terms of number of years, is estimated at 0.7 years on average (Table 4.1).

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<sup>11</sup> The dependency ratio measures the number of inactive persons (i.e. child of 14 years old or less and people of over 64 years old) per active individual in the household (i.e. adults of 15 to 64 years old)

**Table 4.1: Descriptive Statistics of Household Characteristics**

<b>Variables</b>	<b>All sample N=1,178</b>	<b>Non sellers (1) N=523</b>	<b>Sellers (2) N=655</b>	<b>Differences (1)-(2)</b>
Education of Household Head (years)	0.686 (1.990)	0.530 (1.7530)	0.811 (2.155)	-0.282** (-2.41)
Household size	8.805 (4.024)	8.228 (3.873)	9.266 (4.085)	-1.04*** (-4.43)
Dependency ratio	1.563 (0.846)	1.525 (0.849)	1.592 (0.843)	-0.067 (-1.35)
Age of Household Head (years)	48.45 (14.36)	49.44 (14.92)	47.67 (13.86)	1.77** (2.10)
Livestock (TLU)	3.415 (3.624)	3.089 (3.543)	3.676 (3.669)	-0.586*** (-2.76)
Transportation asset (FCFA)	120,674 (176,675)	106,601 (168,078)	131,910 (182,599)	-25308** (-2.44)
Farm size/worker (ha/adult)	1.158 (0.584)	0.987 (0.560)	1.295 (0.566)	-0.31*** (-9.33)
Fertilizer use (kg/ha)	11.24 (34.50)	4.783 (29.60)	16.40 (37.18)	-11.61*** (-5.82)
Agr. Credit received (CFA)	20,448 (79,832)	1,302 (11,022)	35,735 (104,142)	-34433*** (-7.52)
Food crop yield (kg/ha)	521.0 (329.2)	452.4 (270.9)	575.8 (360.1)	-123.44*** (-6.50)
Nonfarm income (FCFA)	354,197 (2.216e+06)	277,739 (586,291)	415,247 (2.925e+06)	-137507.1 (-1.05)
Per capita expenditure (FCFA)	114,866 (77,366)	118,243 (83,016)	112,169 (72,490)	6073.33 1.33
Food expenditure ratio (%)	0.629 (0.139)	0.640 (0.134)	0.620 (0.142)	0.020** (2.50)
<b>Binary variables</b>				
Gender of Household Head (1=man)	0.95 (0.20)	0.946 (-0.22)	0.96 (0.18)	-0.0199* (-1.68)
HH owns transportation asset (1=yes)	0.30 (0.46)	0.27 (0.44)	0.32 (0.46)	-0.052* (-1.96)
HH owns communication asset (1=yes)	0.82 (0.38)	0.77 (0.41)	0.86 (0.34)	-0.082*** (-3.73)
HH is in Nonfarm activities (1=yes)	0.510 (0.500)	0.524 (0.500)	0.499 (0.500)	.024 (0.84)
HH has access to credit (1=yes)	0.29 (0.45)	0.18 (0.38)	0.38 (0.48)	-0.20*** (-7.67)
<b>Village characteristics</b>				
Distance to nearest market (km)	7.186 (6.235)	6.661 (5.398)	7.606 (6.805)	-0.9444*** (-2.58)
Distance to paved road (km)	26.88 (23.30)	27.62 (23.51)	26.28 (23.14)	1.33 0.97
Cereal price (FCFA/kg)	131.7 (18.41)	133.8 (18.63)	130.0 (18.07)	3.787*** (3.52)
Population in the village (inhabitants)	1,556 (1,622)	1,394 (1,498)	1,684 (1,703)	-290.75*** (-3.04)

Note: (\*), (\*\*) and (\*\*\*) indicate the levels of significance of the corresponding coefficients at 10%, 5% and 1% respectively. Standard deviations are reported in parenthesis, except for the difference test where t-statistics are reported

The average level of education is low because the majority of adults in rural areas of Burkina Faso did not attend to any formal education (86.56% of households' head in the sample) while only 10.63% and 2.81% have reached primary and secondary levels respectively. In addition, the level of education of household head is significantly higher among the sellers than non-sellers. This result is similar to that of the national institute of statistics which also highlights a low level of education in Burkina Faso.

The statistics show also that the representative household cultivates 4 hectares of land representing 1.15 ha per adult (i.e. adult between 15 to 64 years old). This is in line with the characteristics of agricultural sector in Burkina Faso dominated by smallholder farmers. Considering the two sub-samples constituted by market participants and non-participants as sellers, the difference in land endowment is significant in favour of crop sellers. In addition, there is a low use of modern inputs by farm households in the sample. In fact, on average, the fertiliser used per hectare of land is 11 kg. This estimate is particularly lower among farm households who do not participate in the markets. In FAO database<sup>12</sup>, the quantity of fertiliser used by farm households in Burkina Faso is estimated at about 10 kg/ha.

Livestock represents an important source of income for many households in Burkina Faso particularly in the Sahel and Northern regions. In this study, livestock asset of the household is evaluated using the indicator of Tropical Livestock Unit (TLU) (In Appendix A is described the method of computation of TLU). The average TLU in the sample is 3.4. Again, crop sellers own significantly more livestock assets than non-crop sellers. Finally, almost all

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<sup>12</sup> <http://fao.org/faostat/en/#data>

the farm households in the sample have nonfarm income. For many of them, nonfarm activities even represent an important source of income. There is no statically significant difference between sellers and non-sellers of crops in terms of nonfarm income. However, only 51% of household heads are engaged in nonfarm activities.

The village level data shows a high remoteness of rural areas in Burkina Faso. Though, the average distance to a nearest market is estimated at about 7 km, the average distance to paved roads is estimated at 27 kilometres. This remoteness, combined with the bad quality of roads increases the level of transaction costs in rural markets thereby reducing the profit that farm households would earn from market exchange. In fact, 72 out of 270 villages (27%) are accessible in all season by motorised vehicle. About 50% is accessible only in dry season while 29% are inaccessible in all seasons (i.e. connected with the closest city with a bad roads). The average price of cereal is 131 FCFA/kg. However, there is a high variability of cereal price from one locality to another. This may be due to high segmentation of market because of transportation conditions. The comparison between non sellers and sellers, according to village level characteristics, shows that sellers are closer to market than non-sellers. Details on the variables are provided in Appendix A.

#### **4.2.2. Assessing the Intensity of Agricultural Commercialisation of Smallholders**

The intensity of farm households' market participation is measured in this study by crop commercialisation index representing the proportion of value of production sold with respect to the value of crop harvested (Equation 3.17). The list of rain-fed crops produced by farm households in Burkina Faso that is considered in this study are: cereal staple crops (sorghum,

millet and sorghum), cotton, rice, beans, peanut, sesame and voandzou<sup>13</sup>. The statistics show that about 45% of farmers did not sell any crop and 28% of farmers sold less than 25% of their outputs. Furthermore, 14% of farmers present an intensity of crop sale that is between 25 to 50% while only 12% sold at least 50% of their crops (Table 4.2).

**Table 4.2: Proportion of Market Participants in the Sample**

<b>Crop Commercialisation index</b>	<b>Observations</b>	<b>% in the sample</b>
No quantity sold (0%)	523	44.40
Less than 25% (< 25%)	340	28.86
From 25 to less than 50% (<=25 ;< 50%)	165	14.01
50% and Above (>= 50 %)	150	12.73
Total sample	1,178	100

In addition, the results presented in Table 4.3 show that roughly 17% of total farm output produced is sold and 55% of farm households participate in agricultural output markets as sellers. Among farmers that sold crops, the quantity brought to market represents on average 30% of their production. Thus, this confirms the fact that not only a huge number of farm households are working on complete subsistence basis, but also among the market participants, market supply of many households is still limited. In the case of Ethiopia, Gebremedhin & Jaleta (2010) estimated at about 25% the proportion of crop harvested that is sold. Carletto et al. (2017) estimated the level of crop commercialisation index (CCI) at 17.6% in Malawi, 27.5% in Tanzania and 26.3% in Uganda.

<sup>13</sup> Of scientific name *Vigna subterranean*, voandzou is also called Bambara bean or earth pea or ground-pea

At crop specific level, cotton has the highest level of commercialisation index (99.7%) followed by sesame (67.7%) and rice (28%)<sup>14</sup> while sorghum and millet present the lowest level of commercialisation. In fact, on average, the commercialisation index of cereal crops (maize, sorghum and millet) is evaluated at 5.2, meaning that only 5.2% of cereal produced (maize, millet and sorghum) is sold.

**Table 4.3: Crop Commercialisation Index (CCI) among Producers and Sellers**

Crops	Producers			Sellers		
	Obs.	% in the sample	Mean of CCI	Obs.	% in the sample	Mean of CCI
Maize	492	41.8	6.54	86	7.30	37.4
Sorghum	1,024	86.9	5.74	185	15.7	31.8
Millet	536	45.5	3.34	69	5.86	26.0
<b>Staple Food</b>	<b>1,178</b>	<b>100</b>	<b>5.19</b>	<b>282</b>	<b>24</b>	<b>21.68</b>
Cotton	151	12.8	99.7	151	12.8	99.7
Rice	161	13.7	28.5	76	6.45	60.4
Groundnut	521	44.2	359.9	286	24.3	655
Peanut	414	35.1	17.2	138	11.7	51.6
Voandzou	89	7.56	21.8	23	1.95	84.5
Sesame	94	7.98	67.7	69	5.86	92.3
<b>All sample</b>	<b>1,178</b>	<b>100</b>	<b>16.97</b>	<b>655</b>	<b>55.60</b>	<b>30.52</b>

These statistics indicate a persistence of subsistence farming and weak integration of smallholder farmers into output markets despite the numerous efforts to promote commercial agriculture in Burkina Faso. This may be related to the fact that agricultural commercialisation policy generally targets more cotton and other high value crops than

<sup>14</sup> Groundnut is not in this classification because its index is greater than 100, i.e. the quantity sold is greater than the quantity harvested. This case may happen particularly when previous stocks have been also sold by the households.

traditional food crops in which the majority of farm households are involved (OECD, 2013). Thus, although all the households in the sample are growing at least one food crop, namely maize, sorghum or millet, only about 24% have reported a positive sale of these crops selling 21.5% of their production. Maize crop which represents the highest level of commercialisation among the staple food crops is sold by only 7% of farmers, and represents 37% of their quantity harvested. The two other crops, sorghum and millet are produced and sold by a greater number of households. However, the proportion of sale among those who participate in the market is very low.

Concerning the other crops, cotton remains by far the most important crop produced for markets. Farmers that are engaged in cotton cropping (13% of the sample) sold almost all their production. As a non-food crop, cotton production is exclusively meant for sale which is encouraged by the institutional framework that links producers to the buying companies. Rice is also produced by only 13% of households. Yet 6.5% of households (representing 45.23% of rice producers) are actually commercialising their product which is estimated at 60% of their production. The remaining crops (groundnut, peanut, voandzou and sesame) are also intensively sold and represent key components of some smallholders' level of market orientation. These crops generally served as primary means to offset the problem of liquidity constraints of farm households in Burkina Faso. Even if there are few producers that are selling, the average proportion of sale among sellers is high.

Considering gender perspective, Table 4.4 shows that the proportion of sale among male-headed households in the entire sample as well as in the sub-sample of sellers is higher than that of females. This seems to suggest that males are more market oriented than females in the agricultural sector in Burkina Faso. However, this can also be an indication that most of

crops included in the computation of commercialisation index are more cultivated by men-headed households or on plot managed by men than women. This gender pattern of cropping has been highlighted by several studies (Carr, 2008; Doss, 2002). In addition, the level of commercialisation increases with land holding. In fact, crop commercialisation index is estimated at 5% for farmers with less than one hectare (1 ha) and about 23% for those who own more than three hectares (3 ha).

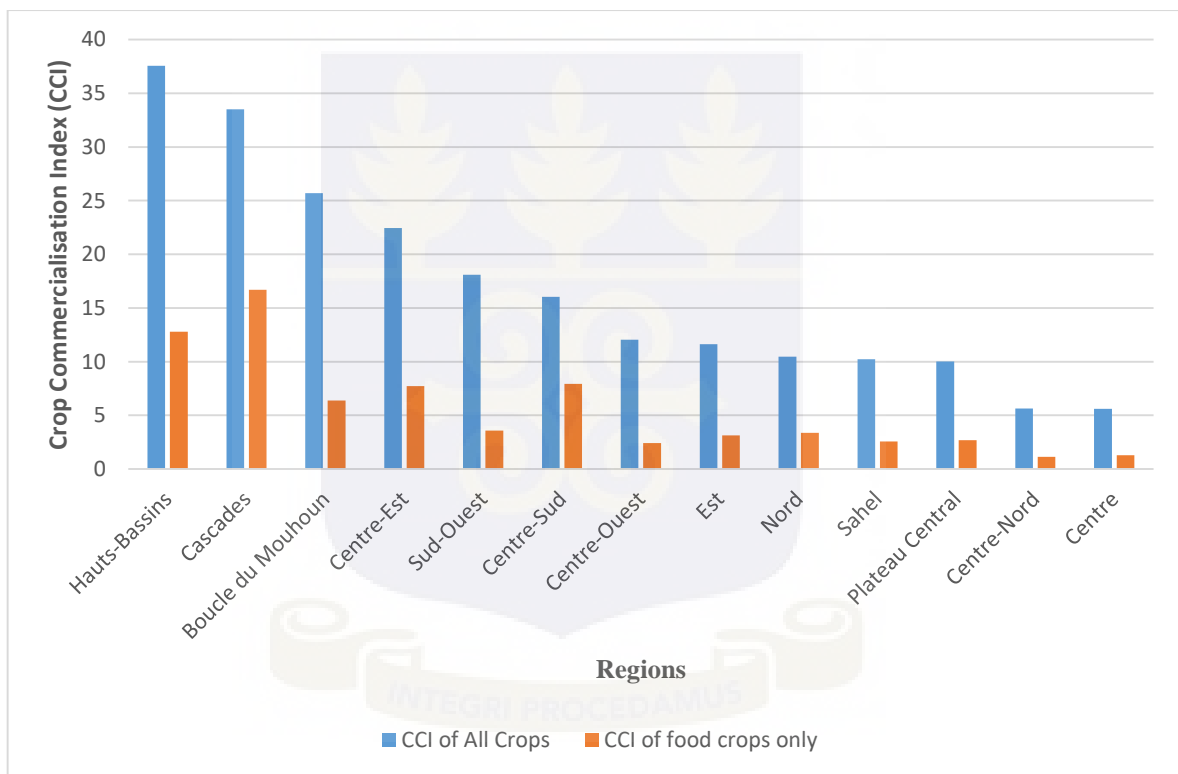
**Table 4.4: Average Intensity of Crop Sale per Gender and per Farm Size**

<b>Variables</b>	<b>Observations</b>	<b>CCI</b>
<b>Gender of household Head</b>		
All Male-headed households	1128	17.22
Crop sellers among Male-headed households	633	30.69
All Female-headed households	50	11.26
Crop sellers among Female-headed households	22	25.70
<b>Household Farm size</b>		
Less than 1 ha	53	5.11
From 1 ha to less than 2 ha	183	6.96
From 2 ha to less than 3 ha	235	9.87
3 ha and above	707	22.811

Furthermore, there are important differences in households' market participation according to their location. The average intensity of commercialisation at regional levels is low in the Centre, Northern and Sahel regions (Figure 4.1). These regions are also located in the climate zones that are less suitable for agriculture. Therefore, both production constraints and cost of market access may be important factors of low level of commercialisation. Western and Southern regions such as Haut-Bassins, Cascades and Boucle du Mouhoun, present the

highest level of commercialisation in terms of food and all output commercialisation. These regions located in the South-Sudan climatic zone enjoy better agro-climatic conditions which are more suitable for agricultural production. These regions which present a commercialisation index close to 50% are the main providers of agricultural produce to the country.

**Figure 4.1: Average Intensity of Crop Commercialisation per Region**



This statistical analysis shows a low level of crop commercialisation by farm households in Burkina Faso. Roughly 17% of agricultural output is sold, involving 55.6% of households in the sample. When the sub-sample of farm households that report a positive sale is considered, the data indicate that on average 30% of output harvested by these farm households is sold.

In the specific case of food crops (maize, sorghum and millet), the average crop commercialisation index is 5.21 representing 21% of production of farmers that participate in the food crops markets as sellers. These indicators not only highlight the low level of integration of farm households to markets, but also show that the majority of farm households in Burkina Faso still produced under subsistence basis.

On the input side, farm households are also characterised by low use of fertiliser (on average 11kg/ha). The low adoption of technology reduces the capability of households to produce a marketable surplus and to increase their market participation. Finally, the remoteness of rural areas and inadequate access to transportation equipment also affect the transaction costs and may impede market participation. However, these statistics cannot show more information about which factors are the most important determinants in households' participation in output markets nor establish the relationship between commercialisation and welfare. The next sections discuss the results of econometrics analysis of the determinants of households' markets participation and the extent to which crop commercialisation and productivity affect rural poverty.

#### **4.3. Determinants of Smallholders' Agricultural Commercialisation**

A double hurdle model (DHM) is estimated for two specifications, namely, (i) the determinants of smallholders' food crop supply, measured by food crop commercialisation index; and (ii) the determinants of smallholders' supply for all crops, measured by crop commercialisation index of all output produced. This allows the identification of the effects of transaction costs factors and access to productive resource on the decision of smallholders' market participation and intensity of crop supply. In addition, the overall effect of each factor

on the intensity of crop sale among smallholders is assessed by the estimation of the unconditional average partial effects (APEs).

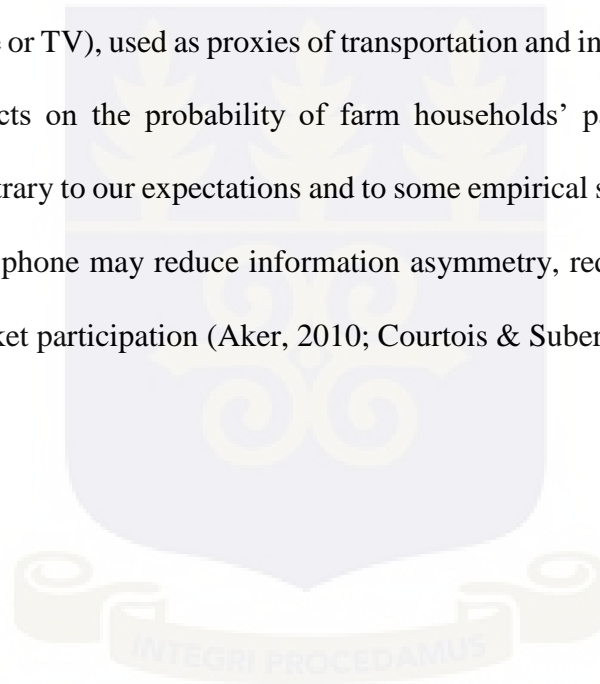
#### **4.3.1. Determinants of Smallholders' Market Participation and Intensity of Crop Commercialisation**

Table 4.5 reports the estimation results of double hurdle model of determinants of participation in agricultural output markets by smallholder farmers in Burkina Faso. Considering the Probit regression in the first stage of the model (hurdle1), the likelihood of farm households' participation in crop markets is positively and significantly affected by farm size per adult (in both regressions). This result supports the point of Barrett (2008) that, the probability to become a crop seller increases when land holding increases. Similarly, Heltberg & Tarp (2002) in the case of Mozambique and Olwande *et al.* (2015) in the case of Kenya found a positive and significant effect of farm size on households' market supply. In Burkina Faso, it is commonly argued that production growth is more driven by increase in farm size than improvement in farm productivity (Kaminski, 2011). This may also explain the central role of farm size on the probability of farm households' decision to participate in market as sellers of crops.

On the other hand, adoption of mechanised system (use of animal traction) increases the probability of farm households' participation in crop market as sellers in both regressions. In addition, at 1% significance level, the use of modern input namely fertiliser increases the probability of being seller of crops. These findings suggest that households' decision to sell crops is closely linked to their access to productive resource and inputs. Indeed, access to these resources may increase farmers' ability to produce a marketable surplus and then their

likelihood to participate in the market. Similar results were found in some African countries. In a study on smallholders' participation in maize market in Kenya, Alene *et al.* (2008) also found a positive effect of use of animal traction on market supply. Boughton *et al.* (2007) in the case of Mozambique and Olwande *et al.* (2015) in the case of Kenya found a positive effect of private assets and access to improved technologies on farm households' market supply.

Household ownership of transportation assets (motorbike or bicycle) and communication assets (radio, phone or TV), used as proxies of transportation and information facilities, show no significant effects on the probability of farm households' participation in food crop market. This is contrary to our expectations and to some empirical studies which suggest that the use of radio or phone may reduce information asymmetry, reduce price dispersion and then stimulate market participation (Aker, 2010; Courtois & Subervie, 2015).



**Table 4.5: Results of DHM of Determinants of Smallholders' Agricultural Commercialisation**

Variables	Hurdle 1		Hurdle 2	
	Probit estimator of Participating in crops market		Truncated normal estimator of intensity of crop sale upon participation	
	Food crops	All crops	Food crops	All crops
Farm size per adult	0.525*** (0.080)	0.566*** (0.077)	5.302 (3.783)	8.205*** (2.649)
Livestock (TLU)	-0.011 (0.013)	0.013 (0.012)	1.136* (0.603)	-0.024 (0.400)
Fertilizer use per ha	0.003*** (0.001)	0.005*** (0.001)	0.029 (0.037)	0.209*** (0.032)
Use traction (1=yes)	0.303*** (0.094)	0.211** (0.084)	0.943 (4.778)	3.591 (3.107)
Credit access (1=yes)	0.275*** (0.092)	0.509*** (0.090)	0.744 (4.295)	18.895*** (2.994)
Nonfarm activity (1=yes)	-0.200** (0.087)	-0.087 (0.080)	2.587 (4.037)	-8.594*** (2.790)
All weather roads (1=yes)	0.094 (0.093)	0.280*** (0.088)	5.313 (4.208)	1.598 (2.837)
Distance to nearest market	0.007 (0.007)	0.009 (0.007)	-0.765** (0.302)	0.232 (0.188)
Own transportation equipment	-0.039 (0.100)	-0.079 (0.093)	4.427 (4.394)	1.494 (3.109)
Own communication equipment	-0.015 (0.122)	0.218** (0.110)	3.950 (6.366)	5.541 (4.417)
Gender (1=man)	-0.203 (0.220)	-0.074 (0.194)	-17.905* (10.271)	-8.318 (8.359)
Age of Household Head (HH)	-0.004 (0.003)	-0.002 (0.003)	-0.122 (0.155)	-0.180* (0.106)
Education level of HH	0.026 (0.021)	0.020 (0.021)	0.948 (0.852)	1.325** (0.602)
Dependency ratio	-0.130** (0.055)	-0.052 (0.050)	0.427 (2.614)	-5.499*** (1.867)
Cereal price in the village	0.0003 (0.002)	-0.003 (0.002)	0.158 (0.107)	-0.062 (0.077)
South-Sudan zone (1=yes)	0.254*** (0.091)	0.104 (0.087)	14.481*** (4.430)	11.560*** (2.950)
Constant	-1.169*** (0.443)	-0.563 (0.407)	-12.517 (21.569)	19.324 (15.239)
Log likelihood		-1694.46		-3464.17
Wald chi2(16)		123.51		163.66
Prob>chi2		0.000		0.000
Observations		1,178		1,178
Sigma		21.937*** (2.034)		25.352*** (1.282)

N.B: (\*), (\*\*) and (\*\*\*) indicate the levels of significance of the corresponding coefficients at 10%, 5% and 1% respectively. Standard errors are in parentheses for the DHM and bootstrap standard errors for the APEs

However, some studies have also found that the effect of access to information on agricultural commercialisation is more important for perishable crops than for traditional staple crops (Fafchamps & Minten, 2012; Muto & Yamano, 2009). The absence of significant effect in our case may also be due to the fact that these communication equipment do not represent the main channel through which market information concerning food crops is provided and that households may instead, have more preference for information received from neighbours as found by Vakis, Sadoulet, & Janvry (2003) in their study on Peruvian smallholders' market participation. In addition, factors of market access such as distance to nearest market and the existence of all-weather roads do not show a significant effect of the probability of selling staple food crops.

However, considering all the crops, ownership of communication equipment has a positive and significant effect on the likelihood of market participation. Though, it does not induce a significant increase in the likelihood of participation in food crop market, having communication equipment (phone, radio or TV) increases the probability of farm households to participate in agricultural output market as sellers by reducing the costs of access to market information. Similar results are found by Goetz (1992), in a study on Senegal grain market, that access to information reduces the transaction costs and increases smallholder market supply. Existence of all-weather roads which is also used as an indicators of transaction costs increases significantly the probability of households' participation in agricultural markets. This is consistent with the empirical findings that, rural isolation increases transaction costs and negatively affects households' market participation (Renkow *et al.*, 2004). In addition, transportation costs which increase in absence of good quality of roads may affect

households' cropping orientation toward subsistence farming and reduce their market supply (Key *et al.*, 2000; Omamo, 1998b).

Furthermore, the results show that households that have access to credit are more likely to participate in markets. Alene *et al.* (2008) report a positive and significant effect of credit access on farm households' market supply. However, if the head of the household is engaged in nonfarm activity, the likelihood of the household selling food crop falls. This effect may be explained by the possibility that access to non-farm activities, which represents an opportunity for income earning, modifies the livelihood strategy of the farm households. This results in a reduction of their reliance on farm income and lowers their incentive to engage in commercial farming, particularly as far as food crops are concerned. However, the effect of participation in nonfarm activity on the likelihood of participation in overall crop sale is not significant.

The estimates of the second stage of the model describing the determinants of conditional market participation are reported in the second column (hurdle2) of Table 4.5. The results indicate that at 5% level of significance, distance to nearest market is negatively correlated with the intensity of food crop sale. This means that once farm households decide to sell food crops, the intensity of sale falls as the distance that separates them from the market increases. Concerning the overall crop commercialisation, the results indicate significant effects of households' productive resources and access to inputs on the conditional intensity of sale (i.e. intensity of participation in crop markets, once market participation decision is made). Furthermore, conditional on market participation, the effect of credit access on the intensity of crop sale is still positive and statistically significant while engaging in nonfarm activity

reduces the intensity of crop sale among market participants. Although, ownership of communication equipment by the household head increases the probability of participation in the crop market (hurdle 1), once participation decision is taken, this factor no longer determines the intensity of sale. This suggests that costs related to information access may be treated as fixed transaction costs which do not affect the intensity of sale (Key *et al.*, 2000).

Other factors such as age of household head and dependency ratio affect negatively the level of crop sale. Thus, the larger the number of inactive members in the household relative to the active members, the lower would be the intensity of crop commercialisation among farm households. In addition, climate condition represents a key determinant in households' decision to participate in crop markets and in the intensity of commercialisation in both regressions. Thus, farm households located in the South-Sudan climatic zone, which is the most suitable zone for agricultural activities in Burkina Faso, are not only more likely to participate in crop market as sellers, but also present significantly higher intensity of sale among crop sellers than those located in the Sahel-Sudan and Sahel climate zones.

These findings show the importance of access to productive resources and improved technologies in improving the intensity of sale among farmers and stimulating new entries of farmers in the market as sellers. This support the hypothesis according to which household private resources increase the likelihood of market participation and intensity of crop sale. In addition, the transaction costs factors such as quality of rural roads and ownership of communication equipment significantly influence the likelihood of smallholders' market participation. However, aside the specific case of food crops where distance to market

reduces the conditional intensity of crop sale, variables related to transaction costs factors (such as distance to market, quality of rural roads, and ownership of communication and transportation equipment) do not present a statistically significant effect on the conditional crop supply.

#### **4.3.2. The Average Partial Effects**

The average partial effects (i.e. the unconditional marginal effects) assess the effects of regressors on the intensity of crop sale regardless of farm households' marketing position. The findings show again the importance of access to productive resources such as farm size, use of animal traction, access to credit and quantity of fertiliser use per hectare on the unconditional level of crop commercialisation (Table 4.6). Indeed, an increase in average farm size per adult by one hectare will result in 3.6 points increase in the intensity of commercialisation of food crops while an increase in fertiliser use per hectare by 10 kilogrammes will lead to increase in the intensity of crop sale by 0.22 units for the overall sample.

Concerning the second regression of all crop sale, the APEs of farm size and fertiliser use are higher (7.5 and 0.10 respectively). In addition, credit access and use of animal traction improve in the overall intensity of sale. Thus, adoption of mechanised agricultural system such as use of animal traction increases the degree of commercialisation of crop output by about 3 units compared to non-adopters. Furthermore, the average partial effect of access to credit is 10, significant at 1%. This means that households that have access to credit, are about 10 units more commercial than those who do not have access to credit.

**Table 4.6: Average Partial Effects Unconditional to Participation Decision**

Variables	Food crops		All crops	
	Coefficients	Std. Err	Coefficients	Std. Err
Farm size per adult	3.600***	0.659	7.515***	1.106
Livestock (TLU)	0.061	0.095	0.108	0.171
Fertilizer use per ha	0.022*	0.0125	0.108*	0.063
Use traction	1.843**	0.798	2.96**	1.398
Credit access	1.660**	0.696	10.261***	1.115
Nonfarm activity	-0.860	0.681	-3.392***	1.179
All weather roads	1.125	0.750	2.965**	1.158
Distance to nearest market	-0.042	0.051	0.150	0.085
Own transportation equipment	0.266	0.710	-0.245	1.294
Own communication equipment	0.353	1.057	3.618**	1.593
Gender	-3.141	1.93	-3.192	3.094
Age of Household Head (HH)	-0.035	0.025	-0.074**	0.035
Education level of HH	0.254	0.183	0.580**	0.260
Dependency ratio	-0.701*	0.385	-2.132***	0.711
Cereal price in the village	0.019	0.0210	-0.041	0.031
South-Sudan zone (1=yes)	3.058***	0.72	4.438***	1.442

N.B: (\*), (\*\*) and (\*\*\*) indicate the levels of significance of the corresponding coefficients at 10%, 5% and 1% respectively. Standard errors are obtained by bootstrapping with 100 replications.

These findings suggest that the limited production capability represents a major cause of low intensity of market participation by farm households in output market. The access to productive resources is therefore important to stimulate farmers' production for markets.

However, none of the proxies of transaction costs show a strong and significant average partial effect (APE) on the level of food crop sale, indicating that access to productive resources represents the key factors explaining the intensity of smallholders' food crop supply in Burkina Faso. However, considering the overall crop commercialisation index

(column 2 of Table 4.6), all the variables of transaction costs factors present a significant average partial effects (APE) on the intensity of crops sale and the expected signs, except the ownership of transportation equipment. Indeed, the quality of rural roads has positive and significant effect on the level of crop commercialisation. Households located in accessible areas are 3 units more commercial than the others. In addition, the APEs of ownership of communication equipment is significantly estimated at 3.5. Thus, farmers which own some communication assets would be 3.5 units more commercial than farmers that do not use any communication equipment. These findings suggest that reducing transaction costs through improving rural accessibility and access to information play a crucial role in commercial orientation of smallholders and their overall market supply.

In summary, the results suggest that productive resources such as farm land and access to improved technologies such as use of animal traction and fertiliser positively affect households' market participation decision and intensity of sale. Furthermore, transaction costs factors such as existence of all-weather roads and ownership of communication assets increase the likelihood of market participation and then the overall level of sale. However, the absence of significant effect of these transaction costs factors on the conditional truncated estimation confirmed the findings which suggest that as fixed transaction costs, they only influence the decision of participation (Goetz, 1992; Key *et al.*, 2000). Finally, the Average Partial Effects shows that both household productive resources and transaction costs factors influence the level of agricultural commercialisation of smallholder farmers.

#### **4.4. Effects of Agricultural Commercialisation on Input Use and Food Crop Productivity**

The second objective of the thesis is to examine the effect of agricultural commercialisation on input use and food crop productivity among smallholder farmers in rural Burkina Faso. The following section presents and discusses the empirical findings based on estimation of Tobit model of fertiliser use and Instrumental Variable regression of food crop productivity.

##### **4.4.1. Effect of Agricultural Commercialisation on Fertiliser Use**

Table 4.7 reports the Tobit regression results of the effect of agricultural commercialisation on fertiliser use by smallholders in rural Burkina Faso. The findings show that, at 1% level of significance, an increase in the level of agricultural commercialisation increases the quantity of fertiliser use. Therefore agricultural commercialisation represents a pathway to improve farm performance through technological change. Indeed, commercialisation directly increase farm households' income and, therefore, their ability to invest in farm production. This finding corroborates the point of Binswanger (1991) and Barrett (2008) which argued that there exists a positive relationship between agricultural commercialisation and technological change, sustaining the importance of promoting farm households' commercial orientation for sustainable technological change. Similar results are also found by Strasberg *et al.* (1999) on food production among smallholders in Kenya. This finding also confirms the hypothesis according to which market participation of smallholder farmers is a key driver of technological change.

**Table 4.7: Results of Tobit Regression of Effect of Agricultural Commercialisation on Intensity of Fertiliser Use**

<b>Dependent variable: Fertiliser use (kg/ha)</b>			
<b>VARIABLES</b>	<b>Coefficients</b>	<b>Robust Std. err</b>	<b>P-Value</b>
Crop commercialisation index	1.021***	0.157	0.000
Agricultural credit received	1.475***	0.431	0.001
Nonfarm income per adult	-0.002	0.013	0.902
Value of transportation assets	0.326***	0.096	0.001
Distance to nearest market	-0.638	0.432	0.141
Existence of all-weather road	16.983***	5.109	0.001
Own Communication assets (1=yes)	18.001**	7.351	0.014
Age of household head (HH)	-0.281**	0.143	0.049
Education level of HH (ref: None)			
Primary	-7.538	6.615	0.255
Secondary	2.273	10.582	0.830
Climatic zone (1=South-Sudan)	11.713**	5.093	0.022
Constant	-65.804***	16.567	0.000
Observations	1,178		
Log pseudo likelihood	-2485.414		
F(11, 1167)	8.97		
Prob > F	0.000		
Sigma	57.448***	11.604	

Note: (\*), (\*\*) and (\*\*\*) indicate the levels of significance of the corresponding coefficients at 10%, 5% and 1% respectively. Robust Standard Errors are adjusted for the 217 village clusters.

The results show also that the value of transportation assets affects positively and significantly the quantity of fertiliser use by farmers as well as the existence of good roads. Thus, the quantity of fertiliser use is higher among farm households located in villages that are accessible compared to those located in less accessible areas. In addition, owning valuable transportation assets can help mitigate the negative effect of remoteness by facilitating households' accessibility to markets. This means that by reducing the cost of

access to fertiliser, improved market access affects indirectly productivity through its positive effect on input use. This is similar to the findings of Damania *et al.* (2016) who showed for the case of Nigeria that improved market access (i.e. decreasing transport costs) increases the production of crops using high input leading to increase in the intensity of input use. Alene *et al.* (2008) also found that among smallholder maize farmers in Kenya, the likelihood of fertiliser demand increases with closeness to market and ownership of transportation equipment. Furthermore, the effect of ownership of communication equipment on fertiliser use is positive and significant. This suggests that households that own communication equipment would be better informed about the price and accessibility of modern inputs and therefore more likely to adopt the inputs intensively.

The amount of credit received by farm households presents a positive effect on fertiliser use, at 1% level of significance. Lack of credit access is frequently identified in the literature as a major constraint of low adoption of new technology among smallholder farmers (Croppenstedt *et al.*, 2003; Nishida, 2014). Particularly in the case of Burkina Faso, access to credit remains of crucial importance to purchase fertiliser, since there are numerous constraints for smallholders to obtain subsidised fertiliser. In addition, even where the subsidised fertiliser exists, smallholders in many cases are still unable to afford because of liquidity constraints. Finally, household characteristics like age of household head significantly affect the quantity of fertiliser use. Thus, the older the household head, the lower the quantity of fertiliser use. This suggests that households led by the aged are less innovative than those led by the youth. In the next sub-section, the results and discussion on the findings on the relationship between agricultural commercialisation and yield of food crops are presented.

#### 4.4.2. Effect of Agricultural Commercialisation on Food Crop Productivity

The results of the effect of agricultural commercialisation on food crop productivity are reported in Table 4.8. The results of OLS regression in the first column indicate a positive effect of market participation on food crop productivity, significant at 1%. However, these results may be biased because the intensity of households' market participation measured by crop commercialisation index is potentially endogenous in this regression (as discussed in the methodological chapter) and this is confirmed by Hausman test of endogeneity at 1% level of significance. To solve the issue of inconsistency of the estimate due to endogeneity, Instrumental Variable (IV) regression approach is then adopted and the estimation results are reported in the second column (Table 4.8). All the estimation results, including the first stage regression, are presented in Appendix C.

The different tests performed and reported below the estimation results assess the relevance and the validity of instruments used. Recall that distance to market, population in the village, ownership of communication equipment and market orientation index are the instruments used for this estimation. The F-test of excluded instruments is greater than 10 and significant at 1%. Therefore, the null hypothesis that the excluded instruments used are not correlated with the endogenous variable is rejected, meaning that the instruments used are relevant. In addition, the KP LM statistic rejects the hypothesis of weak identification of instruments. Thus, the instruments used have a strong explanatory power over the endogenous variable. Furthermore, the F statistic of Cragg-Donald Wald which is significant at 5% according to Stock-Yogo's table suggests that at least 95% of OLS bias is corrected by the IV regression which is highly acceptable. Finally, for the instruments to be valid, they must be orthogonal

to the error terms of productivity model. Thus, the Hansen J test of over-identification is performed to check this requirement. The P-value of the J statistic is equal to 49.7%, greater than 10%. Therefore, the null hypothesis of over-identification of instrument cannot be rejected which means that the instruments used are not correlated with the error terms of the structural model of productivity. Therefore, the instruments used in the regression are valid. As the model passes all the tests of validity and relevance of instruments, the adoption of IV regression will provide more robust estimates of market participation effect on food crop productivity than the OLS estimation. Finally, robust standard errors are reported to correct the existence of possible heteroskedasticity in the model.

The results of IV estimation show a positive effect of commercialisation on food crop productivity, significant at 1% level. This supports the hypothesis that states that there is a positive relationship between agricultural commercialisation and productivity of food crops. Moreover, the magnitude of the estimation is higher in this regression than in the previous OLS regression. This means that failing to control for the endogeneity underestimates the parameters of commercialisation effect. In fact, an increase of one unit in the intensity of farm households' level of crop commercialisation improves food crop productivity by 0.65%. Similar results were found by Govereh & Jayne (2003) in Northern Zimbabwe, Bekele *et al.* (2010) in Ethiopia and Ochieng *et al.* (2016) in a study on Central Africa (Rwanda and DRC). This suggests that one of the benefits of commercial orientation of smallholders is its great potential to transform agricultural sector and raise yield of food crops. The finding also suggests that increase in agricultural commercialisation does not necessarily compete with food crop productivity, but will instead induce an important

technological change and increase in farm yield. This is also reinforced by the positive and significant effect of fertiliser use by farmers on crop yield.

**Table 4.8: Regression Results of Effect of Agricultural Commercialisation on Food Crop Yield**

Dep. variable: Log of staple yield (kg/ha)	OLS regression		IV regression	
	Coefficients	Robust Std. Err	Coefficients	Robust Std. Err
<b>VARIABLES</b>				
Crop commercialisation Index	0.0018**	0.001	0.0065***	0.001
Log of Fertilizer use per hectare (kg)	0.1028***	0.012	0.0799***	0.013
Log of Farm size per adult (ha)	-0.8251***	0.061	-0.8178***	0.062
Log of Livestock ownership (TLU)	0.1518***	0.023	0.1355***	0.024
Nonfarm income per adult	0.0004	0.0001	0.0003	0.0002
Dependency ratio	0.1106***	0.020	0.1111***	0.020
Adoption of conservation techniques (1=yes)	0.0623*	0.036	0.0829**	0.036
Age of Head of Household (HH)	-0.0009	0.001	-0.0003	0.001
Gender of Head of Household (1=man)	-0.0264	0.076	-0.0265	0.075
Education (reference: None)				
Highest education level of HH (1=Primary)	0.1203**	0.050	0.0903*	0.051
Highest education level of HH (1=Secondary)	0.0750	0.109	0.0426	0.112
South-Sudan climate zone (1=yes)	0.1353***	0.032	0.1040***	0.034
Constant	6.1164***	0.104	6.0448***	0.104
Observations	1,178		1,178	
F(12, 1165)	37.71		39.44	
Prob>F	0.000		0.000	
R-squared	0.249		0.222	
<b>Tests of Validity and relevance of instruments used in the IV regression</b>				
	Test stat		P-Value	
<b>Relevance test of excluded instruments:</b>				
Sanderson-Windmeijer F test, F(4, 1145)	176.41		0.000	
<b>Weak identification test</b>				
Kleibergen-Paap rk LM statistic	183.11		0.000	
Cragg-Donald Wald F statistic	215.27			
<b>Over identifying tests:</b> Hansen J stat	2.378		0.497	
<b>Hausman tests of endogeneity:</b> Score chi2(1)	27.239		0.000	

Note: (\*), (\*\*) and (\*\*\*) indicate the levels of significance of the corresponding coefficients at 10%, 5% and 1% respectively.

Other factors that influence the level of food crop yield include the ownership of livestock, adoption of land conservation techniques, and the agro-climatic conditions in which farm households are located. The adoption of good practices such as soil conservation techniques significantly increases the yield of food crops. Land degradation due to population pressure and climate change is frequently cited as a key challenge of agricultural productivity growth in many semi-arid African countries. In Burkina Faso, many farm land is becoming less fertile and farm households are often constrained to adopt land conservation and restoration techniques. Our results show a positive and significant effect of these techniques on food crop yield.

Moreover, livestock asset measured by tropical livestock unit (TLU) significantly increases the yield of food crops. Livestock represents an important production factor for agriculture in Burkina Faso by providing manure and traction service. Therefore, an integration of livestock production and crop cultivation represents a promising strategy to improve yield of food crops. In addition, income gained from livestock sale increases the capability of farmers to invest in productivity enhancing technology. Finally, the results indicate that the level of formal education of household head has a positive influence on productivity. Household heads with at least primary level of education, are more productive than those with no education.

#### **4.5. Agricultural Commercialisation and Poverty Reduction among Smallholders**

##### **4.5.1. Description of Poverty among Smallholder in Rural Burkina Faso**

The Foster-Greer-Thorbecke (FGT) class of poverty indicators showed that 69% of households in the sample are poor, i.e. situated below the poverty line which is estimated at

about 0.7 USD per adult and per day (Table 4.9). Furthermore, the indicator  $P_1$  denoting the depth of poverty is estimated at 0.26. This means that the average per capita consumption expenditure of poor households is 26% below the poverty line. Concerning the inequality among the poor, the results indicate that  $P_2$  is 0.13 (13%). This high incidence of poverty in the sample highlights the situation of rural Burkina Faso. Particularly, it shows how poverty is pervasive among smallholder farmers that are mainly engaged in agricultural activities. In 2010, the National Institute of Statistics (INSD) estimated the level of poverty in rural areas at about 53%. In the same year the indicators of depth and severity of poverty was estimated at 17.5% and 7.9% respectively (INSD, 2016). These statistics of the national institute are lower than the findings of this study. This may be explained by the fact that the sample that is considered in this study concerns exclusively farm households that are involved in the production of food crops (millet, sorghum or maize). Therefore, households that do not produce these crops and large scale farmers are not well represented in this sample. The following section presents the econometrics results of crop commercialisation effect on the probability of rural households to being poor.

**Table 4.9: FGT Class of Poverty Indicators among Farm Households in the Sample**

Variables	Mean	Std. Dev.	Min	Max
Head count ratio (P0)	0.6910	0.462	0	1
Depth of poverty (P1)	0.2632	0.246	0	0.91
Severity of poverty (P2)	0.1300	0.164	0	0.83

#### **4.5.2. Effect of Agricultural Commercialisation on Rural Poverty: The Role of Food Crop Yield**

The Logit estimation results of the effect of agricultural commercialisation and food crop yield on rural poverty in Burkina Faso are reported in Table 4.10 which also reports the corresponding coefficients of odds ratio. The interaction term between commercialisation index of all crop produced and food crop yield is included in the regression in order to highlight the influence of food crop yield on the relationship between crop commercialisation and poverty among smallholders (Appendix D also presents the results and the estimation of the marginal effects).

The findings show that the coefficients of both crop commercialisation index and that of the interaction term between food crop yield and commercialisation index are statistically significant at 5% level. However, the marginal effect of crop commercialisation index on the probability of being poor is positive while the effect of the interaction terms is negative. This suggests that the overall effect of agricultural commercialisation on farm households' welfare and their probability of being poor depends on the level of food crop yield. In fact, at a low level of crop yield, increased agricultural commercialisation results in a positive effect on the probability of being poor. However, with high level of food crop yield, increase in the level of crop commercialisation reduces the probability of being poor.

However, Ai & Norton (2003) have shown that the coefficient of the interaction term estimated in the nonlinear model may not correctly identify the interaction effect and suggested a method for estimating the marginal effect of the interaction term for the particular case of Logit and Probit models. Based on their method and following the

computation package they offer later on in Norton *et al.* (2004), the correct interaction term effect is estimated. Furthermore, the distribution of the interaction effect as function of the predicted probability of the observations in the sample is also presented in Figure (a) and (b) in the Appendix D. However, as regard to the distribution of interaction effect in Figure (a), the correction of the marginal effect of the interaction terms do not differ from the first estimation. Thus, the results reported in Table 4.10 adequately capture the influence of the interaction terms. Therefore, the hypothesis stating the importance of increasing food crop yield in enhancing the poverty reduction effect of agricultural commercialisation holds.

**Table 4.10: Logit Estimation of Effect of Commercialisation on Rural Poverty**

<b>Dependent variable: Poverty status (w)=1 if farmer is poor and 0 otherwise</b>		
<b>Variables</b>	<b>Coefficients</b>	<b>Odds ratio</b>
Crop commercialisation index (CCI)	0.059** (0.028)	1.060** (0.029)
Log of staple yield	0.068 (0.153)	1.071 (0.163)
CCI*Log of staple yield	-0.009** (0.004)	0.991** (0.004)
Dependency ratio	0.152* (0.085)	1.165* (0.098)
Per capita nonfarm income	-0.007*** (0.001)	0.993*** (0.001)
Distance to market	0.033** (0.015)	1.034** (0.016)
Bad roads	0.609*** (0.190)	1.838*** (0.349)
Constant	0.208 (0.926)	1.232 (1.140)
Observations	1,178	1,178
Wald chi2 (7)	82.37	
Prob>chi2	0.000	
Pseudo R2	0.0823	

Note: (\*), (\*\*) and (\*\*\*) indicate the levels of significance of the corresponding coefficients at 10%, 5% and 1% respectively. Robust standard Errors are reported (adjusted for the 217 village clustered).

This means that agricultural commercialisation would reduce rural poverty among smallholders if they attain a high level of food crop yield. On the contrary, in the context of low performance in food crop production resulting in low yield, participation in agricultural commercialisation may result in welfare loss. When farm households face low yield of food crops, increased level of commercialisation may increase the risk of food shortage. Furthermore, a high exposure of farmers to food price fluctuation in the context of low yield may have a detrimental effect. Contrary to some recent studies that found no strong evidence of a positive relationship between agricultural commercialisation and welfare among smallholder farmers (Carletto et al., 2017), this study considers that because food crops represent the predominant crops produced by the majority of smallholders in Burkina Faso, it is likely that the level of the yield plays a crucial role in the effect of participation in agricultural commercialisation on poverty.

Thus, agricultural commercialisation effect on poverty reduction among smallholder farmers in Burkina Faso is closely linked to the level of yield of food crops. Therefore, a successful agricultural transformation requires both the involvement of smallholders in the process and a significant support for the growth of food crop yield in order to raise the poverty reduction effect of increased participation in output markets by smallholders. Furthermore, this finding supports the results of various studies that show the high potential of food crop in reducing poverty among farm households in many African countries (Al-Hassan & Diao, 2007; Diao & Pratt, 2007; Mellor & Malik, 2017). Dutilly-Diane *et al.* (2003) indicated that the activity choice of farm households in Burkina Faso is influenced by their performance in food production explaining thereby, the persistence of subsistence food crop production most often at expense of non-food production for markets. Similarly, Dzanku (2015a) found, in a

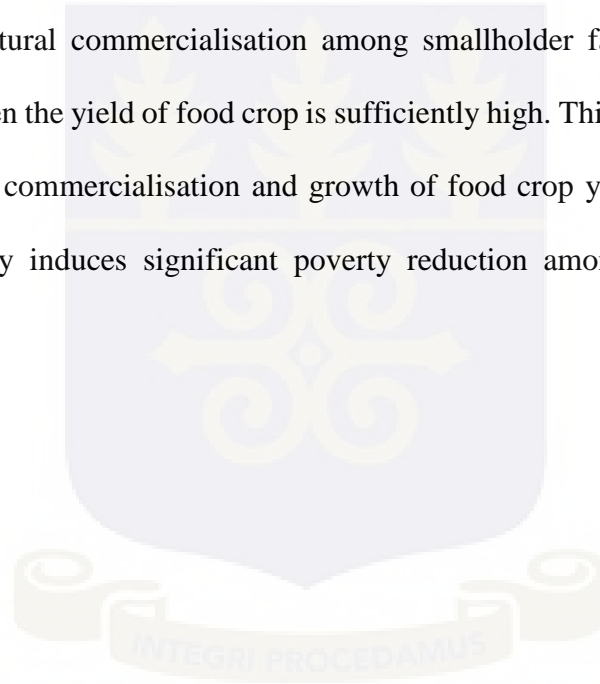
study on Ghana, that promoting agricultural commercialisation through increased adoption of high value crops may fail to produce the expected outcome in the context of low productivity of staple crops.

Globally, the coefficients of most of the control variables present the expected signs. Thus, distance to market and lack of good roads increase the probability of being poor. By experiencing high transportation and input costs, and limited access to non-farm opportunities, households living in rural areas that lack access to good roads or located away from markets are more likely to present a lower level of consumption and higher likelihood of being poor than those having access to markets or living in areas that are connected to urban areas by good roads. Numerous empirical studies have found a positive effect of rural isolation and bad transportation condition on poverty in developing countries through various channels. Some examples of studies include Stifel & Minten (2016) in Ethiopia, Renkow *et al.* (2004) in Kenya, and Damania *et al.* (2016) in Nigeria.

In addition, access to nonfarm income significantly reduces the probability of being poor. This finding highlights the importance of nonfarm income in livelihoods of rural households and how its promotion can help alleviate rural poverty. Similar results are found by Savadogo, Reardon, & Pietola (1998) in Burkina Faso. Numerous studies have also emphasised the role of nonfarm economy for farm households in developing countries (Lanjouw & Lanjouw, 2001; Tsiboe, Zereyesus, & Osei, 2016). Essentially, by improving farm households' access to food and modern technologies through reducing their liquidity constraints, nonfarm activities may have positive effect on farm productivity and household welfare. Concerning household socio-economic characteristics, the results show that a high

dependency ratio is associated with a higher probability of being poor. This means that households with higher number of dependants relative to the number of active members, are more likely to be poor.

This section analysed the effect of commercialisation in agriculture on rural poverty and the extent to which this relationship is influenced by the level of food crop yield. The study presents a new approach in analysing welfare effect of agricultural commercialisation among smallholders by emphasising the specific role of food crop yield. The results indicate that an increase in agricultural commercialisation among smallholder farmers is more likely to reduce poverty when the yield of food crop is sufficiently high. This suggests that promoting jointly agricultural commercialisation and growth of food crop yield represents a strategy that can adequately induces significant poverty reduction among smallholders in rural Burkina Faso.



## CHAPTER FIVE

### SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

#### 5.1. Introduction

Promoting agricultural commercialisation among smallholders in developing countries has been seen for long as a promising strategy for rural poverty reduction. However, despite the various policy interventions aiming at increasing farm households' market integration in Burkina Faso, the majority are still working under subsistence basis with low level of output supply. Yet, empirical evidence on the drivers of smallholders' agricultural commercialisation is still limited. In addition, the existing studies concerning the extent to which commercialisation affects rural households' welfare are not conclusive and most of the findings are context specific depending on the agricultural potential of the countries. In order to expand the existing literature and reduce the knowledge gap, the general objective of this thesis was therefore to analyse the factors that explain smallholders' marketing behaviour and the extent to which agricultural commercialisation and food crop productivity affect rural poverty in Burkina Faso. The research addressed three key questions: (i) What are the underlying factors that affect the level of agricultural commercialisation of smallholder farmers in Burkina Faso? (ii) What is the relationship between agricultural commercialisation and farm productivity? (iii) Are improvements in market participation and food crop productivity both needed to alleviate rural poverty?

The study was conducted using survey data collected in 2011 at national level from a sample of 1,178 farm households selected from 270 villages in the 13 regions of the country. The

level of smallholders' agricultural commercialisation (or intensity of market participation) was assessed using crop commercialisation index which described at household level the proportion of the value of crop sale with respect to the total value of harvest. The descriptive statistics highlighted a low participation of farm households in agricultural commercialisation. Indeed, 55.6% of the sample have reported having participated in agricultural market as sellers and selling on average 30% of crop harvested. Considering the overall sample, the data indicated that only 17% of crop output is sold in the market. In addition, there were significant differences in the intensity of crop sale across the various regions of the country and according to household farm size and gender of the head. In the regions located in better agro-climatic conditions (South-Sudan climatic zone), farm households present on average the highest commercialisation index. In addition, the intensity of crop sale is higher among male-headed households and those with a relatively large farm size.

The next section summarises the key findings for each objective of the thesis which is followed by some policy recommendations. Finally, the chapter concludes with the perspectives for future research.

## **5.2. Key Findings**

### *Factors affecting smallholders' marketing behaviour*

Numerous factors are identified as having important effects on farm household's market supply in developing countries. Among them, the most important include the level of transaction costs and households access to productive resources and improved technology.

Thus, using a double hurdle model, the influence of these factors on smallholders' market participation and intensity of commercialisation is analysed. The results showed that access to productive technology and resources such as adoption of mechanised system (use of animal traction), the quantity of fertiliser use per hectare, access to credit and farm size per adult as well as transaction costs factors such as ownership of communication equipment and existence of all-weather roads increase significantly the likelihood of farm households' market participation when commercialisation index of overall crop produced is considered. Yet, conditional to market participation, factors of transaction costs do not show strong effects on the intensity of sale. Thus, these factors may be seen as indicators of fixed costs which influence only the first decision to sale or not the intensity. Furthermore, the average partial effects of both productive resources and transaction costs factors on the intensity of crop sale are statistically significant. This means that unconditional to participation decision, the overall intensity of sale are positively explained by both access to productive resources and factors reducing transaction costs. However, considering the specific case of food crop commercialisation, the results indicate that access to productive resources represents the key drivers of farm households' food crop supply.

*Agricultural commercialisation, technological change and productivity*

Food crop which is the most important crop produced by smallholders in Burkina Faso experiences a very low productivity. Furthermore, it is generally admitted that subsistence farming entail inefficiency and keep smallholders in low equilibrium of low input use and low yield. Thus, the second objective of the study was to analyse the effect of agricultural commercialisation on input use and food crop yield. The results based on Tobit regression

indicated that the intensity of fertiliser use per hectare increases with the level of smallholders' agricultural commercialisation. Other variables that positively influence farm household access to fertiliser include the value of transportation assets, the amount of credit received for farm activities, the existence of all-weather road that link households to urban areas and the household head ownership of communication assets. Moreover, estimating a productivity function using instrumental variables regression approach, the results show that farm households' crop commercialisation index has a significant and positive effect on crop yield. Therefore, promoting agricultural commercialisation will lead to a positive technological change in agricultural sector and an increase in food crop productivity.

#### *Agricultural commercialisation and rural poverty*

Promoting agricultural commercialisation has the potential of raising rural income and reduce poverty. Yet, if the target does not include a significant support to food crop growth, commercialisation can result in welfare loss especially among smallholders. Thus, the extent to which food crop yield influence the relationship between agricultural commercialisation and rural poverty is examined. Based on Logit regression, the results show a significant influence of food crop yield on the sign and the magnitude of the effect of agricultural commercialisation on the likelihood of being poor. Indeed, for households with low yield in food crops, the overall effect of an increase in intensity of commercialisation is a reduction in welfare while an increase in agricultural commercialisation in a context of high yield of food crop reduces the likelihood of being poor. This results sustain the importance of supporting the growth of food crop yield for a more significant effect of investment in agricultural sector on rural poverty.

### **5.3. Conclusions and Policy Recommendations**

The key message of the study is, therefore, that commercial agriculture represents a promising strategy to alleviate poverty among smallholders in rural Burkina Faso. However, without growth in food crop productivity, there is a risk that this will not produce the expected outcome. In addition, lowering transaction costs and improving farm households' access to productive assets are important to induce significant and successful shift to more commercial farming system. Thus, the following recommendations are to guide agricultural and food policies aiming at inducing significant market entry of smallholders and reducing rural poverty particularly in semi-arid countries characterised by the predominance of smallholding and food crop production.

For households to profitably benefit from market participation and increase their market supply, there is a need for reducing remoteness-induced transaction costs in agricultural sector. Therefore, policymakers should give special attention in unlocking rural areas by improving the quality of road infrastructure and farm households' access to information. In addition, the results indicated that improving rural access will not be enough to ensure successful market entry by smallholders because of constraints in access to productive resources. Thus, promoting farm households' participation in agricultural market requires that agricultural policy facilitates their access to improved technologies (such as fertiliser) and credit. Finally, agricultural commercialisation policy needs to take into account, location-specific factors such as agro-climatic conditions.

The need for promoting agricultural commercialisation also resides in its technological change effect which leads to growth in crop yield. Therefore, to sustainably support food

crop productivity growth, policymakers should promote commercial farming of smallholders. In addition, increase in agricultural commercialisation is more likely to have a significant poverty reduction effect among farmers with high yield of food crops. These crops are predominant in smallholders' crop portfolio and their productivity are important to enhancing the effect of agricultural commercialisation on poverty reduction. Therefore, agricultural policy should grant more attention to supporting the growth of food crop production. This means that for a significant poverty reduction among smallholder farmers in rural Burkina Faso, policy that promotes agricultural commercialisation should consider the issue of raising the yield of food crops as part of this strategy. Thus, agricultural commercialisation and food crop yield need to be jointly promoted in order to have significant effect in terms of income growth and poverty reduction among smallholders. This would not only increase the level of commercialisation in food crops but also grant households the possibility to adopt high value crop production according to their comparative advantage without bearing high risk of welfare loss due to food deficit and eventual price shocks.

#### **5.4. Perspectives for Future Research**

Past studies were mainly interested in welfare effect of farm households' diversification toward non-food cash crops. This study, however, by considering agricultural commercialisation in terms of extent of sales of all crop harvested, provides a more complete analysis of smallholders' market integration. In addition, a corner solution model namely Double Hurdle Model used to analyse the determinants of intensity of crop supply, contrary to Heckman switching regression model used in previous studies, has the advantage of

explaining the nonparticipation in markets by both a rational choice due to limited level of production and the high costs in accessing markets. Another methodological contribution of this study resides in the use of Instrumental Variables method to analyse the effect of agricultural commercialisation on food crop productivity. Thus, the use of instruments has helped to obtain more robust estimators. Finally, by identifying the yield of food crop as an important factor in the welfare effect of agricultural commercialisation, this study provides a new motivation for promoting food crop growth in smallholder agriculture.

Yet this thesis is not exempt from some limitations and can be improved. First of all, the cross-sectional dataset used in this study reduces the ability to assess the pattern of agricultural commercialisation and represents a key limitation of the study. Thus, further investigations based on panel dataset would be important to understand the process of agricultural commercialisation and how it influences in the long-term the household level of specialisation/diversification. Furthermore, the role of transaction costs in farm household's market supply has been emphasised in this study. However, the effect of transaction costs has been indirectly assessed using variables that are susceptible to influence their level. Thus, studies that seek to evaluate their magnitude in agricultural markets may be useful in informing public policy on pro-poor agricultural market development. Studies could also explore a wider concept of commercialisation of smallholders by including vegetables, fruits and livestock production but this would require a certain prudence as regard to the high heterogeneity of the products that this extension would involve. At the same time this study opens a perspective for further research on commercial farming and smallholders' livelihoods in developing countries.

For instance, high food price volatility is seen as having a detrimental effect on farm households' welfare and may reduce their investment in agriculture. However, price stabilisation policy is often seen as costly and there is still an on-going debate on its potential effect on the welfare of poor households (Bellemare, Barrett, & Just, 2013; McBride, 2015). There is, therefore, a need for further investigations on how to reduce farm households' exposure to market risk in order to stimulate smallholders' investment in commercial farming. This is particularly important as regard recent food crisis that has been an underpinning factor of implementation of various models of agricultural commercialisation in developing countries especially in Africa, most often at the expense of smallholders. These various models which generally include contract farming, large scale production systems, however, have heterogeneous impact on farm households' employment, tenure security and sustainability of livelihood (Hall, Scoones, & Tsikata, 2017; Matenga & Hichaambwa, 2017; Yaro, Teye, & Torvikey, 2017). This posits numerous challenges in terms of economic viability of smallholders and their welfare (Deininger, 2017). Therefore, further empirical studies might focus on the influence of commercial farming on rural employment and smallholders land security in developing countries.

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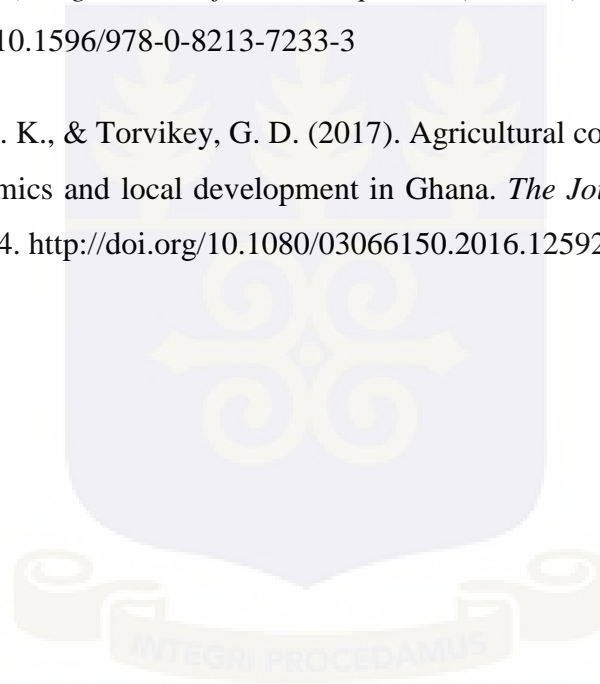
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## APPENDICES

**Appendix A: Measurements of Variables and Descriptive Statistics****1. Measurements of some Variables****- Tropical Livestock Unit (TLU) and Value of Livestock Asset**

Tropical livestock Unit (TLU) is the indicator used to assess farm households' resources in livestock. It is computed using a conversion factors to convert all the livestock that household owns in the same unit and then sums up the quantity obtained. Mathematically, the Tropical Livestock Unit ( $TLU_i$ ) for a given household  $i$  can be expressed as:

$TLU_i = \alpha_1 P_{i1} + \dots + \alpha_n P_{in} = \sum_{j=1}^J \alpha_j P_{ij}$  where the  $\alpha_j$ s denote the conversion factors representing the weight assigned to each species of animal  $j = 1, \dots, J$  and  $P_{ij}$  the number of

animals that the household  $i$  possesses in this species  $j$ . The conversion factors ( $\alpha_j$ ) for each species varies across the world. In the case of semi-arid African countries the conversion factor is given as follow:

**Conversion Factor of Livestock**

<b>Species</b>	<b>Conversion factor</b>
Camels	1
Cattle	0.7
Sheep and goats	0.1
Horses	0.8
Mules	0.7
Asses	0.5
Pigs	0.2
Chicken	0.01

Source: <http://www.fao.org/Wairdocs/ILRI/x5443E/x5443e04.htm>. Last access date: 20/12/2017

We also evaluate Livestock asset in monetary unit (i.e. in FCFA). This represents the value of household livestock evaluated using the average market price of each species.

**- Nonfarm income**

Nonfarm income represents the summation of income from three distinctive sources including (i) wage received from off-farm labour supply (i.e. agricultural activities), (ii) the profit obtained from nonfarm business and (iii) transfer received by the households net of transfer granted to other households.

- **Value of transportation equipment**

The value of transportation equipment is a self-evaluation by the household of the value of all the transportation assets it owns. This asset includes motor bikes and bicycles. To obtain the value of transportation assets, households were asked the following question: if you would have to sell your transportation asset (mentioning the name of the asset concerned) today, how much are you ready to sell it?

- **Household consumption expenditures**

Total consumption expenditures are used in this study as indicator of household welfare. They include food and non-food expenditures. Concerning food expenditures, food items are grouped into 12 categories. Similarly, non-food expenditures are grouped into 8 categories (see table below). However, only expenditures in non-durable goods have been taking into account. Expenditures in durable goods such as purchasing of house or transportation equipment are not included in the computation of consumption expenditures. These kinds of expenditure can instead be assimilated to capital expenditures.

The valuation of household expenditure uses a mix recall period. This means that it is first asked to the households the frequency of consumption of each goods (if consumed by the household over the last 12 months). Thus, for goods that are frequently consumed (i.e. over

10 months or more) the total expenditure over the last three months is asked. For good that is less frequently consumed (i.e. over less than 10 months), the total expenditure during the last 12 months is recorded. This procedure is used in order to reduce the recall bias in the evaluation of expenditure.

In addition, for each items, household self-consumption is included. Households are asked to evaluate in monetary unit (FCFA) the value of self-consumption where this is applied. In self-consumption, it is distinguished goods that are consumed more frequently (each month), less frequently (each three month on average) from goods that are consumed infrequently (each six months on average). The value of self-consumption is therefore recorded for each household according to the periodicity with which he consumes the given good.

Finally all consumption expenditure are converted in a one year basis and then in per capita expenditure. The following table lists the group of food and non-food items that are considered in the computation of consumption expenditure.

**Group of Food and Non-Food Items**

<b>Food items</b>	<b>Non-food items</b>
1. Cereals	1. Dressing material/dressmaking
2. Food-based cereals	2. Clothing/shoes
3. Tubers and roots	3. Health care
4. Fruits and legumes	4. Movable property
5. Poultry and eggs	5. Kitchen utensils
6. Meats and fish	6. Distraction/entertainment
7. Vegetable oils and butter	7. Transportation and communication
8. Milk and dairy products	8. Other non-food goods and services
9. Ingredients, spices and sugar	
10. Drinks	
11. Cooked food	
12. Other food items	

## 2. Descriptive Statistics of the Variables

VARIABLES	Mean	Min	Max
Household size	8.805	1	20
Dependency ratio	1.563	0	6
Age of Household head	48.45	18	98
Education level of Household head	0.686	0	12
Total farm size (ha)	3.930	0.200	18.20
Farm size per worker (ha/adult)	1.158	0.0653	2.920
Staple crop farm size (ha)	0.953	0.0357	2.868
Proportion of cereal farm size (%)	83.5	10.0	100
Fertiliser (kg/ha)	11.24	0	600
Fertiliser in cereal land (kg/ha)	8.746	0	613.8
Fertiliser in cotton (kg/ha)	25.46	0	2,250
Maize yield (kg/ha)	350.4	0	3,000
Mil yield (kg/ha)	214.7	0	2,000
Sorghum yield (kg/ha)	446.8	0	2,000
Food crop yield (kg/ha)	540.6	106.4	2,056
Cotton yield (kg/ha)	122.6	0	3,000
Farm income (1000 FCFA)	444.3	6.253	5,514
Nonfarm income (1000 FCFA)	354.2	-407.4	68,092
Total income (1000 FCFA)	798.5	31.71	68433.73
Food Crop Commercialisation Index (%)	5.191	0	78.04
All Crop Commercialisation Index (%)	16.97	0	85.36
Agricultural credit (1000 FCFA)	20.448	0	1,000
All credit received (1000 FCFA)	27.513	0	1,000
TLU	3.415	0	19.90
Livestock asset (1000 FCFA)	554.4	0	3,780
Transportation asset (1000 FCFA)	120.7	0	1,678
Food expenditure (FCFA)	129,610	1,500	1.171e+06
Total expenditure (FCFA)	597,966	48,400	4.113e+06
Per capita food expenditure (FCFA)	72,776	5,386	751,755
Total per capita expenditure (FCFA)	114,866	11,000	800,327
Ratio of food expenditure (%)	62.9	17.2	100
Distance to market (km)	7.186	0	30
Population	1,556	83	9,717
Distance to paved road (km)	26.88	0	100
Cereal price (FCFA/kg)	131.7	74.46	178.1

## Appendix B: Estimation Results of Determinants of Smallholders' Crop Commercialisation

### 1. Double Hurdle Model of Staple Food Crop Commercialisation

	Coef.	Std. Err.	z	P>z
Log likelihood = -1694.4641 <span style="float: right;">             Number of obs = 1178              Wald chi2(16) = 123.51              Prob &gt; chi2 = 0.0000           </span>				
<b>Tier1</b>				
fsiz	.5252467	.0803957	6.53	0.000
TLU	-.0112948	.0132547	-0.85	0.394
fert_ha	.0033537	.0012654	2.65	0.008
traction	.303207	.0944222	3.21	0.001
crd	.2750182	.0923499	2.98	0.003
nonfarm	-.1995535	.0866448	-2.30	0.021
access1	.0936051	.0928156	1.01	0.313
dist	.007487	.0067315	1.11	0.266
trsprt	-.0389298	.1000784	-0.39	0.697
comm	-.0145842	.1217973	-0.12	0.905
gender	-.2029324	.2195508	-0.92	0.355
age	-.0038177	.0031434	-1.21	0.225
edu_levl	.0261466	.0206958	1.26	0.206
dep_ratio	-.1304666	.0554566	-2.35	0.019
cer_price	.0003342	.0023285	0.14	0.886
guinean	.2536476	.0912753	2.78	0.005
_cons	-1.169013	.4433549	-2.64	0.008
<b>Tier2</b>				
fsiz	5.301573	3.783252	1.40	0.161
TLU	1.135766	.6030009	1.88	0.060
fert_ha	.0289522	.0368812	0.79	0.432
traction	.9426864	4.777679	0.20	0.844
crd	.7435262	4.29459	0.17	0.863
nonfarm	2.586962	4.036767	0.64	0.522
access1	5.312945	4.207804	1.26	0.207
dist	-.7650462	.3020889	-2.53	0.011
trsprt	4.426716	4.393512	1.01	0.314
comm	3.949666	6.36595	0.62	0.535
gender	-17.90491	10.27062	-1.74	0.081
age	-.1219609	.1548971	-0.79	0.431
edu_levl	.9481988	.8518963	1.11	0.266
dep_ratio	.4270487	2.613912	0.16	0.870
cer_price	.1577727	.1067239	1.48	0.139
guinean	14.48138	4.429605	3.27	0.001
_cons	-12.51722	21.5694	-0.58	0.562
sigma				
_cons	21.93684	2.033532	10.79	0.000

**2. Double Hurdle Model of all Crop Commercialisation**

Log likelihood = -3464.171      Number of obs = 1178  
 Wald chi2(16) = 163.66  
 Prob > chi2 = 0.0000

	Coef.	Std. Err.	Z	P>z
<b>Tier1</b>				
fsiz	.5659274	.0772651	7.32	0.000
TLU	.0130732	.0121106	1.08	0.280
fert_ha	.0050135	.0013746	3.65	0.000
traction	.2106249	.0843833	2.50	0.013
crd	.5085277	.089876	5.66	0.000
nonfarm	-.0874524	.0799695	-1.09	0.274
access1	.2795815	.0876952	3.19	0.001
dist	.0089385	.0068549	1.30	0.192
trsprt	-.07898	.0932115	-0.85	0.397
comm	.2178045	.1097164	1.99	0.047
gender	-.0743728	.1938029	-0.38	0.701
age	-.0021884	.0028207	-0.78	0.438
edu_levl	.0198866	.0205719	0.97	0.334
dep_ratio	-.051641	.0497806	-1.04	0.300
cer_price	-.0025735	.0021773	-1.18	0.237
guinean	.1036148	.0870567	1.19	0.234
_cons	-.5629213	.4074722	-1.38	0.167
<b>Tier2</b>				
fsiz	8.205021	2.648527	3.10	0.002
TLU	-.0241162	.40003	-0.06	0.952
fert_ha	.2088823	.0323618	6.45	0.000
traction	3.590572	3.107026	1.16	0.248
crd	18.89536	2.99413	6.31	0.000
nonfarm	-8.593702	2.789905	-3.08	0.002
access1	1.598279	2.837477	0.56	0.573
dist	.2319432	.188226	1.23	0.218
trsprt	1.493871	3.108855	0.48	0.631
comm	5.540865	4.417348	1.25	0.210
gender	-8.317779	8.359305	-1.00	0.320
age	-.1795811	.1064036	-1.69	0.091
edu_levl	1.325221	.6022428	2.20	0.028
dep_ratio	-5.498758	1.867385	-2.94	0.003
cer_price	-.0619984	.0769124	-0.81	0.420
guinean	11.55994	2.949798	3.92	0.000
_cons	19.32389	15.23936	1.27	0.205
<b>sigma</b>				
_cons	25.35195	1.281913	19.78	0.000

**Appendix C: Estimation Results of Effects of Agricultural Commercialisation on Fertiliser Use and Food Crop Productivity**

**1. Tobit Regression of Effect of Commercialisation on Fertiliser Use**

Tobit regression

Number of obs = 1178

F( 11, 1167) = 8.97

Prob > F = 0.0000

Log pseudolikelihood = -2485.4145

Pseudo R2 = 0.0662

(Std. Err. adjusted for 217 clusters in vill)

fert_ha	Coef.	Robust Std. Err.	t	P>t
CCI_all	1.020551	.1567751	6.51	0.000
agr_cr1	1.474724	.4312123	3.42	0.001
pcnonfarm_income	-.0015663	.0127321	-0.12	0.902
trs_asset	.3256771	.0958381	3.40	0.001
dist	-.6376671	.4324845	-1.47	0.141
access1	16.98251	5.10875	3.32	0.001
comm	18.00133	7.351168	2.45	0.014
age	-.2812606	.1428103	-1.97	0.049
education				
primary	-7.538175	6.615452	-1.14	0.255
secondary	2.272616	10.58154	0.21	0.830
climate				
pre-guinean	11.71324	5.092597	2.30	0.022
_cons	-65.80389	16.56732	-3.97	0.000
/sigma	57.44773	11.60423		

Obs. summary: 777 left-censored observations at fert\_ha<=0  
 401 uncensored observations  
 0 right-censored observations

## 2. Instrumental Variables Regression of Productivity Model

First-stage regressions

First-stage regression of CCI\_all:

Statistics robust to heteroskedasticity

Number of obs = 1161

CCI_all	Coef.	Robust Std. Err.	t	P> t
HMOI	1.203501	0.046106	26.1	0.000
dist	0.150297	0.082585	1.82	0.069
pop	0.000243	0.000307	0.79	0.428
comm	1.930688	1.284634	1.5	0.133
lfert_cerha	0.650036	0.432244	1.5	0.133
lcerfarmsiz	11.81324	2.035885	5.8	0.000
lTLU	0.797141	0.721023	1.11	0.269
pcnonfarm_income	0.012892	0.007097	1.82	0.07
dep_ratio	-0.80813	0.568007	-1.42	0.155
conservation	-2.25256	1.112092	-2.03	0.043
age	-0.01977	0.033241	-0.59	0.552
gender	0.562585	2.304709	0.24	0.807
education				
primary	4.647391	1.841542	2.52	0.012
secondary	3.973204	3.564264	1.11	0.265
climate				
pre-guinean	-2.1465	1.034107	-2.08	0.038
cons	-11.7904	3.290805	-3.58	0.000

F test of excluded instruments:

F( 4, 1145) = 176.41

Prob > F = 0.0000

Sanderson-Windmeijer multivariate F test of excluded instruments:

F( 4, 1145) = 176.41

Prob > F = 0.0000

Summary results for first-stage regressions

Variable	F( 4, 1145)	P-val	(Underid) SW Chi-sq( 4)	P-val	(Weak id) SW F( 4, 1145)
CCI_all	176.41	0.0000	715.49	0.0000	176.41

NB: first-stage test statistics heteroskedasticity-robust



**Second stage regression**

IV (2SLS) estimation

-----

Estimates efficient for homoskedasticity only  
 Statistics robust to heteroskedasticity

		Number of obs = 1161
		F( 12, 1148) = 39.44
		Prob > F = 0.0000
Total (centered) SS = 417.3007646		Centered R2 = 0.2224
Total (uncentered) SS = 43853.37083		Uncentered R2 = 0.9926
Residual SS = 324.4926593		Root MSE = .5287

lyi	Coef.	Robust Std. Err.	z	P> z
CCI_all	0.006458	0.001111	5.81	0.000
lfert_cerha	0.079928	0.012773	6.26	0.000
lcerfarmsiz	-0.81776	0.061994	-13.19	0.000
lTLU	0.13555	0.023516	5.76	0.000
pcnonfarm_income	0.000345	0.000286	1.21	0.228
dep_ratio	0.111138	0.019819	5.61	0.000
conservation	0.0829	0.036145	2.29	0.022
age	-0.00029	0.001148	-0.25	0.799
gender	-0.02646	0.074547	-0.35	0.723
education				
primary	0.090296	0.051436	1.76	0.079
secondary	0.042603	0.112068	0.38	0.704
climate				
pre-guinean	0.104024	0.033592	3.1	0.002
cons	6.044824	0.10395	58.15	0.000

Underidentification test (Kleibergen-Paap rk LM statistic): 183.110

Chi-sq(4) P-val = 0.0000

-----

Weak identification test (Cragg-Donald Wald F statistic): 215.279

(Kleibergen-Paap rk Wald F statistic): 176.407

Stock-Yogo weak ID test critical values: 5% maximal IV relative bias 16.85

10% maximal IV relative bias 10.27

20% maximal IV relative bias 6.71

30% maximal IV relative bias 5.34

10% maximal IV size 24.58

15% maximal IV size 13.96

20% maximal IV size 10.26

25% maximal IV size 8.31

Source: Stock-Yogo (2005). Reproduced by permission.

NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

-----  
Hansen J statistic (overidentification test of all instruments): 2.378  
Chi-sq(3) P-val = 0.4977

-endog- option:

Endogeneity test of endogenous regressors: 27.239  
Chi-sq(1) P-val = 0.0000

Regressors tested: CCI\_all  
-----

Instrumented: CCI\_all

Included instruments: lfert\_cerha lcerfarmsiz lTLU pcnonfarm\_income  
dep\_ratio conservation age gender 1.education 2.education 1.climate

Excluded instruments: HMOI dist pop comm



**Appendix D: Logit Estimation of the Relationship between Agricultural Commercialisation and Rural Poverty**

**1. Estimation Results and Derivation of Marginal Effects**

Logistic regression Number of obs=1178  
Wald chi2(7)=82.37  
Prob>chi2=0.0000  
 Log pseudolikelihood = -668.4442 Pseudo R2=0.0823  
(Std. Err. adjusted for 217 clusters in vill)

w	Coef.	Robust Std. Err.	z	P> z
CCI_all	0.058564	0.027555	2.13	0.034
lyi	0.068164	0.152501	0.45	0.655
ccily	-0.00942	0.004305	-2.19	0.029
dep_ratio	0.152482	0.084562	1.8	0.071
pcnonfarm_income	-0.00723	0.001289	-5.61	0
dist	0.033312	0.015373	2.17	0.03
access3	0.608897	0.189853	3.21	0.001
cons	0.208275	0.925624	0.23	0.822

**Estimation of the Marginal Effect**

Marginal effects after logit  
 $y = \text{Pr}(w)$  (predict)  
 =.66649856

variable	dy/dx	Std. Err.	z	P> z
CCI_all	0.013018	0.00608	2.14	0.032
lyi	0.015152	0.03395	0.45	0.655
ccily	-0.00209	0.00095	-2.2	0.028
dep_ratio	0.033894	0.01868	1.81	0.07
pcnonfarm_income	-0.00161	0.00031	-5.18	0
dist	0.007405	0.0034	2.18	0.03
access3*	0.126751	0.03751	3.38	0.001

## 2. Computing the Interaction Effect Based on Norton et al (2004)

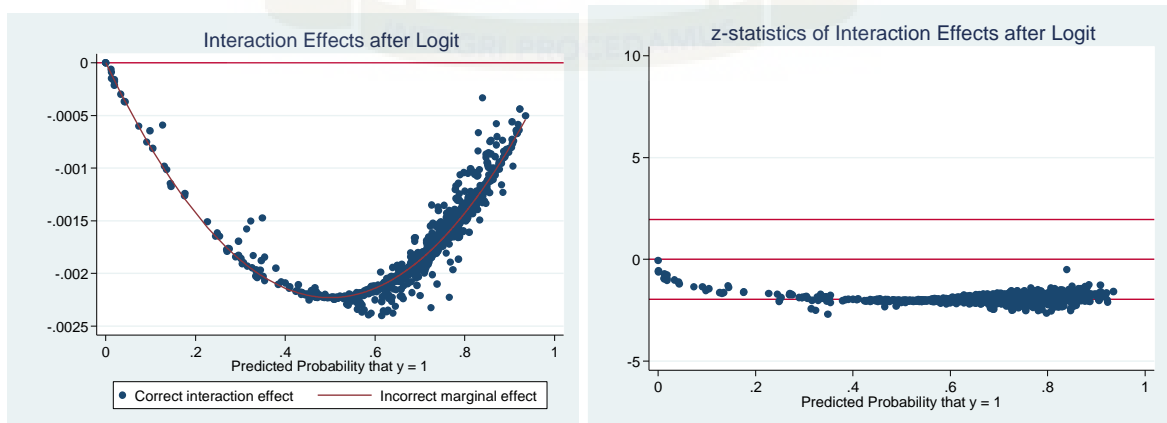
### Estimation of the Interaction Effect and z-statistics

Logit with two continuous variables interacted

Variable	Obs	Mean	Std. Dev.	Min	Max
Interaction effect	1178	-0.0019	0.000546	-0.00314	0
Standard error	1178	0.001002	0.000279	0	0.00208
Z-statistics	1177	-1.89186	0.244276	-2.86146	-0.0325

Figure A1 (a), shows that almost for all the household in the sample, the interaction effect is negative, i.e. an increase in the yield of food crops improves the effect of agricultural commercialisation on households' welfare and reduces their likelihood of being poor. In addition, the distribution of estimated marginal effects fit the corrected marginal effects. However, for households whose predicted probability is less than 0.4, the interaction effect is not significant (Figure A1 (b)). The effect is more perceptible among household whose predicted probability of being poor is about 0.6 to 0.8. This shows how important is the growth of food yield and agricultural commercialisation among poor smallholder farmers.

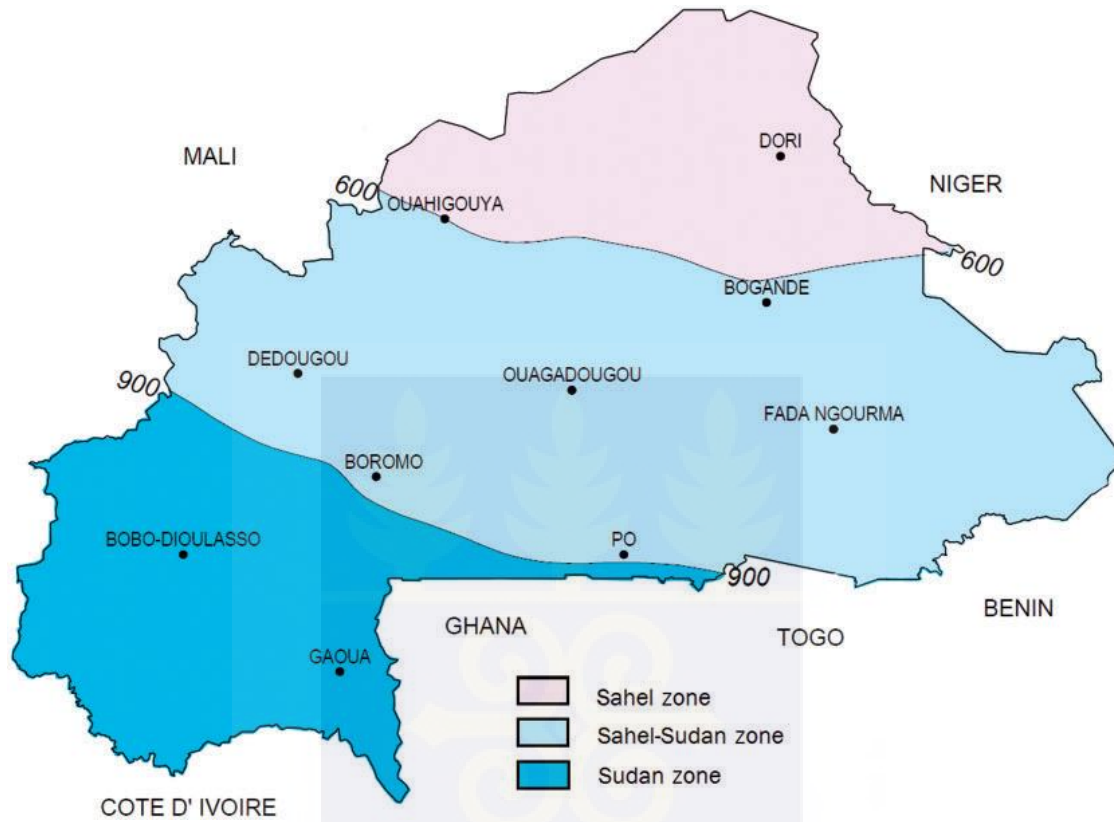
**Figure A1: Distribution of Interaction Effect (a) and Z-Statistic (b) as a Function of the Predicted Probability**



(a)

(b)

**Appendix E: Agro-Climatic Zones in Burkina Faso**



Source: Ministère de l'Environnement et du Cadre de Vie (2007) (cited by Kazianga & Makamu (2016))

The annual rainfall in the Sahel zone situated the extreme North is below 600 mm. The area with the annual rainfall between 600mm and 900 mm in the centre is named Sahel-Sudan zone. With the average annual rainfall that is above 900 mm and rainfall season lasting around 180 to 200 days, the southern part is describes as Sudan zone or South-Sudan zone.