IMPACT OF CASSAVA MARKET PARTICIPATION ON FARMERS' ECONOMIC EFFICIENCY AND POVERTY LEVEL IN MAIGANA AGRICULTURAL ZONE, KADUNA STATE, NIGERIA

BY

Francois SIEWE
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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER IN SCIENCE DEGREE IN AGRICULTURAL ECONOMICS

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY,
FACULTY OF AGRICULTURE, AHMADU BELLO UNIVERSITY, ZARIA

June, 2015

DECLARATION

I hereby declare that this dissertation titled "**Impact of Cassava Market Participation on Farmers' Economic Efficiency and Poverty Level in Maigana Agricultural Zone, Kaduna State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All citations and sources of information are duly acknowledged by means of references.

Francois SIEWE Student	**Date**

CERTIFICATION

This dissertation titled "**Impact of Cassava Market Participation on Farmers' Economic Efficiency and Poverty Level in Maigana Agricultural Zone, Kaduna State, Nigeria",** by Francois **SIEWE** meets the regulations governing the award of the Degree of Master of Science, Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

______________________________ ______________________

Prof. Ben Ahmed **Date**
Chairman, Supervisory Committee

______________________________ ______________________

Dr. M.A. Damisa **Date**
Member, Supervisory Committee

______________________________ ______________________

Prof. Z. Abdulsalam **Date**
Head of Department
Agricultural Economics and Rural Sociology,
Ahmadu Bello University

______________________________ ______________________

Prof. A. Z. Hassan **Date**
Dean, School of Postgraduate Studies,
Ahmadu Bello University

DEDICATION

This dissertation is dedicated to God Almighty and my family.

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Abstract

This study investigated the impact of cassava market participation on farmer's economic efficiency and poverty level in Maigana agricultural zone, Kaduna state, Nigeria. A multi-stage sampling technique was used to collect primary data with the aid of a structured questionnaire from 150 cassava farmers from two major cassava producing Local Government Areas in Maigana agricultural zone, Kaduna State namely, Soba and Kudan. The data were analyzed using descriptive statistics, Stochastic Frontier Functions (SFF), Foster-Greer-Thorbecke (FGT) poverty decomposition model, Kitchen Sink Tobit (KST) regression model and Propensity Score Matching (PSM) estimator. The results revealed that cassava farming was profitable in the study area with gross margin and net farm income of NGN 140, 943.35 and NGN 94, 297.47 respectively. Cassava farmers who participated in processed and fresh cassava market realized NGN 3.33 and NGN 1.98 by investing NGN 1per hectare respectively. The results further showed that the cassava farmers were economically inefficient and poor. The impact of cassava market participation on economic efficiency was insignificant. However, the findings revealed a positive and significant impact of cassava market participation on poverty level. Specifically, the results suggested that participation in cassava market raised farm household per capita income by an average of NGN 12, 163.83 which is about NGN 158, 129.79 annually for a household, thereby reducing their probability of falling below the poverty line. It was therefore recommended that government should make credit accessible to farmers through reduction of interest rates which will stimulate them to invest more in the production and marketing of cassava.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Agriculture constitutes 70% of the principal livelihood of the world's poor and it is the main source of food security in most developing countries (Onwuemele, 2013). Nigeria is generously endowed in many natural resources and human capital. Its economy, although quite diversified, relies more heavily on the petroleum and agricultural sectors. In Africa, it is the most populous country with an estimated population of 170 million followed by Ethiopia and Egypt. The agricultural sector's share of GDP was 37% between 1960 and 2008 and rose to 40.87% in 2010 which makes agriculture the most dominant Nigerian economic sector over the period of study.

Agriculture and poverty are closely linked in developing countries. Most of the poor work in the agricultural sector where their low agricultural productivity and income prevent their movement out of poverty (Eboh *et al.*, 2012). Poverty in Nigeria is a rural phenomenon. Approximately 74 % of the rural population in Nigeria are described as poor and are comprised predominantly of resource-poor farmers, cultivating an average of about two hectares of land usually on scattered holdings with low and declining productivity (National Bureau of Statistics, 2012). The World Bank (WB) and the United Nations Development Programme (UNDP) recognize that agricultural growth is a necessary condition for a sustainable reduction in poverty (Ponty, 1998). In fact, according to the World Bank (2007), growth originating from agriculture could be up to four times as effective in reducing poverty as growth originating outside of the agricultural sector.

Though agricultural growth is essential and desirable, this does not always translate into development and reduction of poverty especially if appropriate redistribution of income and social protection policies such as climate change are not taken into account (Nigerian Institute of Social and Economic Research, 2013). GDP growth in Nigeria averaged 6% in the period 2004-2007 and rose further to 6.94 % in 2008-2010 making the country one of the fastest economies in the world (NISER, 2013). Despite these impressive improvements on average, poverty and inequality are found to be growing in the same direction in recent years. Referring to the proportion of Nigerians that are living on less than US $1 a day, poverty rate increased from 51.6% in 2004 to 61.2% in 2010 (Yemi, 2012).

Poverty appears to be location specific in Nigeria based on recent statistics. Yemi (2012) noted that the majority of poor are located in the North-West with a poverty incidence of 70.4% against 50.1% in the South-West which is regarded as the less affected geo-political zone in terms of proportion of poor rural households. The Harmonized Household Living Standard Survey (HHLSS, 2012) equally revealed that the Gini coefficient increased from 0.429 in 2004 to 0.447 in 2010 suggesting higher income inequality among the Nigerian population in the course of time. Women have higher poverty rates than men in almost all societies (Casper *et al.*, 1994). Poverty gap in Nigeria is not only location specific but also gender specific. Bolarin (2009) showed that the determinants of poverty significantly differ across male-headed and female-headed households in Nigeria.

Recent studies have emphasized that agricultural commercialization is an indispensable pathway towards economic growth and development for the majority of developing countries relying mostly on the agricultural sector (Pingali and Rosegrant 1995; von Braun 1995; Timmer 1997). Following the implementation of the Doi Moi reforms in the late 1980s that aimed at transforming subsistence agriculture into commercial agriculture, Vietnam has experienced remarkable economic growth and an impressive reduction in poverty (Chiara *et al.*, 2010). In effect, rice production increased dramatically and Vietnam was transformed from being a net rice importer to being one of the world's largest rice exporters. According to the World Bank (2004), two thirds of farmers previously primarily engaged in subsistence farming are estimated to have entered the market following the process of liberalization in Vietnam.

Agricultural production entails investment of resources, and farmers will have no incentive for making investments in areas where there is little opportunity for marketing their products, or if the returns accruing from the sales of agricultural products do not reflect the opportunity cost of investment. As a result, most farmers in areas with few marketing opportunities are engaged primarily in subsistence agriculture, which has unfortunately constrained improvement in their quality of life. Commercial transformation of subsistence agriculture, according to literature, depends heavily on the triplet market orientation, market access and market participation. Market orientation is the degree of allocation of resources (land, labor and capital) to the production of agricultural produce that are meant for exchange or sale (Hinderink and Sterkenburg, 1987; Immink and Aarcon, 1993). Market access is a combination of three factors namely physical access to markets (distance to markets), market structure (usually oligopoly) and finally organization of market (Marketing association) and market information (Understanding of markets). Market participation on the order hand is defined as produce offered for sale and use of purchased inputs (Berhanu and Moti, 2010).

The trade theory posits that if households participate in markets by selling surplus of what they produce on a comparative advantage basis, they are set to benefit not only from the direct welfare gains but also from opportunities that emerge from economies of large-scale production (Siziba *et al.*, 2011; Barrett, 2008). Market participation of smallholder agriculture leads to gradual decline in real food prices due to increased competition and lower costs in food marketing and processing. These changes improve the welfare of smallholder farmers in two ways: low food prices increase the purchasing power for food of consumers while, to producers, a decline in food prices enables reallocation of limited household incomes to high value non-food agribusiness sectors and off-farm enterprises. Despite the stream of benefits that are inherent with market participation, studies show that participation in market by smallholder farmers in developing countries is very low and has slowed down agriculture driven economic growth and exacerbated poverty level (Barret, 2008). As such subsistent farmers cannot benefit from the welfare gains and income growth associated with market participation.

This study focuses on cassava market participation. Cassava is a tropical root crop - originally from Amazonia - that provides the staple food of an estimated 800 million people worldwide (FAO, 2013). It is one of the most important crops for Nigerians. It is important, not just as a food crop but even more so as a major source of cash income for producing households. As a cash crop, it generates cash income for the largest number of households, in comparison with other staples, contributing positively to poverty alleviation. The New Partnership for African Development (NEPAD) has also identified cassava as a crop that can be used to reduce poverty in Africa and has recommended more intensity in its production.

Since 2000, the world's annual cassava production has increased by an estimated 100 million tonnes, driven in Asia by demand for dried cassava and starch for use in livestock feed and industrial applications, and in Africa by expanding urban markets for cassava food products. Booming demand offers millions of cassava growers in tropical countries the opportunity to intensify production, earn higher incomes and boost the food supply where it is most needed. But how smallholder cassava growers choose to improve productivity should be of major concern to policymakers (FAO, 2013).

1.2 Statement of the Problem

Over the years, remarkable progress in Nigeria have been made by agricultural research and development organizations on increasing agricultural productivity and promoting intensification of major food crops for small scale farmers. In particular, the impact of the various efforts of governmental and non-governmental organizations geared towards growth in agriculture is significant on cassava crop production across the country as a whole as an average of about 4.92% growth rate in cassava yield is observed between 2000 and 2012 (FAO, 2014). In other words, there has been an improvement in cassava productivity across the country over the period under consideration. Performance evaluation through productivity and efficiency assessment, identification of inefficient farmers and the causes of their inefficiency to guide policy are very well known and important as they help understanding the type of actions to undertake in order to reduce production cost and increase profitability. Between1999 to 2007, Kaduna, Benue and Enugu states were the only states with a land area under cassava cultivation of more than 200 thousand hectares. However, out of these three states, Kaduna State was the only state with an average yield ranging between 1 and 2 million metric tons per year whereas Benue state, the highest producer, and Enugu state had an average yield of more than 2 million metric tons. Moreover, Kaduna state was found to be less productive than other states such as Imo and Cross River that had put an average of less than 200 thousand hectares of land under cassava cultivation (Okoro and Ujah, 2009). Despite the above fact, there appears to be scanty information in recent past on productivity and efficiency analysis of cassava production in Kaduna State in order to determine the level of efficiency of cassava farmers and to uncover possible factors hindering their performance in the production of the crop.

Nigeria's Agricultural Trade Policy seeks to exploit all the trade potentials of agricultural products both within the domestic and external market opportunities. It equally seeks the achievement of competitive quality and standard certified products to satisfy local demands and attain export competitiveness. Under Yar' Adua's administration, commercial agriculture was one of the key elements of the 7-point agenda to ensure the promotion of sustainable economic growth and the achievement of the Millennium Development Goals (MDGs) by 2015 and vision 2020. It was expected to accelerate resource flow from private investors, good quality human capital and technology-driven production systems. It was intended to promote market-based production systems that are driven by efficient and sustainable technologies (Okoro and Ujah, 2009). However, not only that there are few works on cassava market participation in Nigeria as a whole and Kaduna State in particular, various comparative studies in this area focused on market participants and non-participants by assuming homogeneity within each group. Moreover, the assessment of potential economic efficiency difference that might inherently exist across different categories of cassava market participants is often neglected. Scanty empirical evidence of the impact of cassava market participation on efficiency as it is expected by Nigeria's Agricultural Trade Policy is another gap in the literature.

It's against the aforementioned gaps observed in the literature and in particular in the case of Kaduna State that this study, in an effort to complement literature and create more awareness among those interested in Kaduna's state cassava production and commercialization, sought to assess the profitability, economic efficiency, poverty profile, processed cassava market participation and its impact on economic efficiency and poverty level in the study area through the following research questions:

i. what are the socioeconomic characteristics of cassava farmers?

ii. what is the profitability of cassava production?

iii. what is the economic efficiency level of cassava farmers?

iv. what is the poverty profile of cassava farmers?

v. what are the factors affecting the poverty status of cassava farmers?

vi. what are the factors affecting the level cassava market participation?

vii. what is the impact of cassava market participation on economic efficiency level?

viii. what is the impact of cassava market participation on poverty level?

Broad objectives

This study sought to estimate the impact of cassava market participation on farmers' economic efficiency and poverty level. The specific objectives were to:

i. describe the socioeconomic characteristics of cassava farmers in the study area

ii. examine the profitability to cassava production,

iii. examine the economic efficiency level of cassava farmers,

iv. examine the poverty profile of cassava farmers,

v. determine the factors affecting the poverty status of cassava farmers,

vi. determine the factors affecting the level of cassava market participation,

vii. estimate the impact of cassava market participation on economic efficiency level,

viii. estimate the impact of cassava market participation on poverty level.

1.3 Justification of the Study

Sustainable success in productivity-based agricultural growth critically depends on expansion of market opportunities and requires a holistic view beyond productivity to incorporating profitability and competitiveness (Diao, 2004; Kaplinsky, 2000). In the opinion of Ehui and Holloway (2002), the inability to have access to markets is a major constraint for improving the welfare of small scale farmers. In other words, market participation can help sustaining production intensification.

Any hope for the poor to participate in markets and make any meaningful gains from agriculture lies in improving productivity of their labour as well as improving their access to land (Olwande and Mathengue, 2012). This is even more so in the Nigerian context where smallholder farmers are found to have low productivity level often due to misallocation of resources which is regarded as a consequence of environmental, ecological and socioeconomic changes. This comparative analysis of small scale farmers under different cassava market participation systems is important as it will enable one to know which category of cassava market participation systems gives higher likelihood to have better ability to improve their standard of living.

The outcomes of this study will generate information for policy makers, governmental and nongovernmental organization and all those interested in cassava production and commercialization in Kaduna state to design and develop effective framework for sustainable livelihood strategies and policies among small scale cassava farmers. Specifically, findings of this research will provide empirical evidence of the quantitative impact of different cassava market participation on poverty alleviation and economic efficiency of small scale farmers in the study area. Moreover the methodology developed in this study and the results could serve as a basis upon which similar or improved studies can be undertaken.

1.4 Statement of Hypotheses

Based on the objectives of the study the following hypotheses will be tested:

i. there is no significant impact of cassava market participation on economic efficiency level

ii. there is no significant impact of cassava market participation on the poverty level

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin, Uses, Importance and Trend of Cassava Production in Nigeria

Cassava (*Manihot esculenta* L. Crantz) originated from Central and Southern America and has since then spread to various parts of the world (FAO, 2001). Grown almost exclusively by low-income, smallholder farmers, it is one of the few staple crops that can be produced efficiently on a small scale, without the need for mechanization or purchased inputs, and in marginal areas with poor soils and unpredictable rainfall. Its systemic cultivation became generally accepted and integrated into the farming system in Nigeria and based on the area cropped and quantity produced, cassava was the country's most important root crop (Akparaobi *et al.*, 2007).

Cassava is a very versatile commodity with numerous uses. Each component of the plant can be valuable to its producer. The leaves may be consumed as a vegetable or cooked as a soup ingredient or dried and fed to livestock as a protein feed supplement. The stem is used for plant propagation while the roots are typically processed for human and animal consumption (Ojukaiye, 2001). Cock (2001) stated that cassava tuber flesh is composed of about 62 % water, 35 % carbohydrate, 1-2 % protein, 0.3 % fat, 1-2 % fibre and 1 % mineral. The leaves have also been found to contain about 17 % protein and therefore a good source of protein in the diet of man and most ruminant animals (Elfick, 1998).

Nigeria produces more cassava than any other country in the world with an annual output of over 44 million MT of tuberous roots since 2008 (see Table 1 below). The crop is abundant in 24 of the 36 states and it requires minimum labor and inputs. It remains the most important food security crop for millions of Nigerians. Apart from being a staple crop in both the rural and urban households, cassava alone contributes 45% for agricultural GDP in Nigeria for food or domestic purposes (Foraminifera Market Research, 2012).

Today, the amount of food available per person on a global basis is 18 % higher than 30 years ago (Echebiri *et al*, 2008). In Nigeria the expansion of cassava production has been relatively steady since 1980 with an additional push between the years 1988 to 1992 owing to the release of improved IITA varieties. Nigeria is the leading producer of cassava, in 1993 – 1995; 84 million MT of cassava were produced per year in sub-Saharan Africa. Of this, 75% was produced in 4 countries; Nigeria, 31 million MT representing 36.9%, Congo 19 million MT (22.62%), Tanzania, 7 million MT (8.33%), Ghana, 6 million MT, (7.14%) (FAO, 2000). Out of 186 million MT produced in the world, Nigeria accounted for 36 million MT (Tell, 2004) and in 2004 production was 55.69 million MT (CBN, 2004).

Table 2.1: Cassava Production Trend in Nigeria from 2000 to 2012

Year	Output (tons)	Yield (tons/ha)	Growth Rate (%)
2000	32, 010	9.70	
2001	32, 068	9.60	0.18
2002	34, 120	9.90	6.40
2003	36, 304	10.40	6.40
2004	38, 845	11.00	7.00
2005	41, 565	10.99	7.00
2006	45, 721	12.00	10.00
2007	43, 410	11.20	-5.05
2008	44, 582	11.80	2.70
2009	36, 822	11.77	-17.41
2010	42, 533	12.22	15.51
2011	52, 403	14.02	23.21
2012	54, 000	14.03	3.05

Source: Fao (2014).
Average Yield Growth Rate: 4.92%

2.2 Agricultural Policies and Cassava Programmes in Nigeria

Within the last three decades serious efforts have been made to make Nigerian economy self-sufficient in food production. One of those efforts was the establishment of the state wide Agricultural Development Programmes (ADPs) in 1974 (Mabawondi, 1986). The broad objective of ADP in any State was to increase food production and farm family incomes of rural population. In Nigeria, government awareness of the importance of increased food production for feeding the teaming population has mobilized support for better methods of tuber and root crops production. Thus a large volume of research has been done on root and tuber crops in research institutes such as the National Root Crop Research institute Umudike Umuahia and the International Institute of Tropical Agriculture (IITA), Ibadan and in the Universities.

Following the completion of the Cassava Multiplication Programmes (CMP) which made Nigeria the largest cassava producer in the world, the Root and Tuber Expansion Programme (RTEP) was formulated by the Food and Agricultural Organization (FAO) investment center in 1999 and negotiated by the International Fund for Agricultural Development (IFAD) Executive Board in 1999. The project was launch in December 2000 and was declared loan effective on 31st July 2001. The overall objective of the RTEP was to achieve sustainable increase in the production of cassava, yam and cocoa yam and improve rural household food security and income.

To decrease dependency on wheat imports, the Nigerian Government policy is encouraging the use of cassava for bread making. A number of fiscal policies to support this cassava substitution plan have been launched. As part of the cassava policy, the government is facilitating the acquisition of compact modular milling systems that will allow the bakers mix their own cassava flour with wheat flour in the right ratios.

2.3 Determinants of Rural Poverty

Obisesan (2012) employed a Tobit model to identify the determinants of poverty. The results of the Tobit regression model showed that age, years of education, off-farm income, access to credit, household size, commercialization extent and access to market information were significant variables. These results generally suggest that in order to effectively alleviate poverty, there should be improved market information systems with strong linkages between crop producers and end users.

Bolarin (2009) conducted a quantitative analysis of poverty in Nigeria. He employed an exponential and a fixed effect regression models to estimate the determinants of welfare among rural Nigerian households using panel data where the dependent variable was measured as the ratio of per capita expenditure to poverty line. He used a pool sample of farmer to estimate the factors of poverty. Subsequently he estimated those factors across gender and the six geopolitical zones. The study showed changes in poverty status and their determinants between the year 1996 and 2004 among rural households. Education was found to be a key factor in reducing poverty irrespective of the gender of the household head and the geopolitical zones. Household size was found as the second most important determinant of poverty. It was found to reduce the level of welfare irrespective of the household head gender and geopolitical zone. The study also revealed that the estimation of separate models of welfare across gender and the geopolitical zones was justified using Show test. The reason given is that there were significant agro-ecology differences as one moved from the South to the North.

Alemayehu *et al* (2001) studied the determinants of poverty in Kenya at a household level. It used both a binomial and an ordered logit models to estimate the factors affecting the probability to fall in a specific category of poverty. In the first model the explained variable was a binary variable taking 1 if poor and 0 otherwise. It was then regressed on variables such as education, age, gender, marital status, employment sector, area of residence. In the second model the regressand was a trichotomous response variable taking 1 if non-poor, 2 if moderate poor and 3 if extreme poor all regressed on the same set of covariates. The Variable such as gender, marital status, employment sector and education were significant factors of poverty status irrespective of the model employed. Separate models for urban and rural households were equally estimated but the results were in general equal to those estimated from the national sample. Primary education was found to be extremely significant in reducing the probability to be in higher level of poverty in the rural sector. The results reveal that the determinants of poverty have differing effects across poverty categories. Female education was also a significant variable. Female-headed household were found to be more likely than male to be poor. Thus, promoting female education was found to be a significant poverty reduction strategy. The study also reveal higher probability for those engaged in agricultural activities to be poor suggesting more investment in the agricultural sector.

2.4. Poverty Profile in Nigeria and among Farmers

Nigeria occupies a land area of 923,768 km^2 while only 33.02% is arable and 2820 km^2 is irrigated as at 2003 (Mailumo, 2007). Nigerian farmers cultivate over 30 million hectares of crops annually, 80-90% of which are cereals (Mahmood, 2007). This shows that most Nigerian depend either directly or indirectly to agriculture. For instance 55% of the work force is engage in agricultural activities with about 70% of them living in rural areas (IFAD, 2001).

Despite the fact that the agricultural sector is one of the essential building blocks that form the foundation of the Nigerian economy, a good proportion of those who are involved (rural households) are the most affected by poverty. Poverty in Nigeria is essentially a rural phenomenon (NISER, 2013). The following table gives a good picture of the trend of poverty across geopolitical zones and sectors from 1980 to 2010.

Table 2.2: Poverty incidence in Nigeria by geopolitical zones and sectors (1980-2010)

Geopolitical Zones	1980	1985	1992	1996	2004	2010
North East	35.6	54.9	54	70.1	72.2	76.3
North West	37.7	52.1	36.5	77.2	71.2	77.7
North Central	32.2	50.8	46	64.3	67	67.5
South East	12.9	30.4	41	53.5	26.5	67
South West	13.4	38.6	43.1	60.9	43	59.1
South-South	13.2	45.7	40.8	58.2	35.1	63.8
SECTOR						
Urban	17.2	37.8	37.5	58.2	43.2	61.8
Rural	28.3	51.4	46	69.3	63.3	73.2
National	28.1	46.3	42.7	65.6	54.4	69

Source: Nigerian Institute of Social and Economic Research (NISER, 2013)

2.5 Concept of Agricultural Commercialization and Market Participation

Several definitions of market participation can be identified in the literature. According to Berhanu and Moti (2010), market participation can be defined as produce offered for sale and use of purchased inputs based on the principles of profit maximization. That is, producers can participate in output market through sale of their produce and/or input market through purchase of inputs such as improved seed and fertilizer. According to Rios, Shively and William (2009), market participation is defined in terms of sales as a fraction of total output, for the sum of all agricultural crop production in the household; this includes annuals and perennials, locally-processed and industrial crops, fruits and agro-forestry. It is the integration of subsistence farmers into the inputs and output markets of agricultural products, with the aim of increasing their income level thereby reducing poverty (Holloway and Ehui, 2002).

Agricultural commercialization has often been used synonymously with agricultural market participation in the literature. In effect, Berhanu and Moti (2010) in their work entitled: “Commercialization of Smallholders: Is Market Participation Enough?” emphasized on the fact that commercialization is a combination of market orientation (agricultural production destined for market) and market participation. In their study, they observed that, although market orientation strongly translate into market participation, market participation on the other hand does not translate into market orientation in Ethiopia and as such suggested different policies to improved both market participation and market orientation. Thus, increased market participation will increase commercialization but not necessarily in a sustainable manner since a household could have high market participation because of surplus production due to various reasons, including favorable weather conditions (Berhanu and Moti, 2010).

Recent studies on market participation have employed diverse approaches or methodology to determine whether a farmer is said to participate in market or not depending on whether output or input market was considered and one or more crops output or input were considered. According to Leykun and Jemma (2014), in a study entitled “Econometric analysis of factors affecting market participation of smallholder farming in Central Ethiopia”, many crops were considered and farmers were categorized into three groups of market participation from the output market perspective. They called the categorical variable crop output market participation scenarios. These included, subsistence farmers (degree of participation is less than 25%), transitory farmers (degree of participation is between 25% and 50%) and commercial farmers (degree of participation is more than 50%). The degree of participation was estimated as the ratio of the gross value of all crops’ sales to the gross value of all crops produced times 100.

Following this methodology, it was observed that market participation was at a transitory stage in Ethiopia. Rios, Shively and William 2009; Berhanu and Moti, 2010; Egbetokun and Omonona, 2012 are among many other authors who also considered several crops in assessing market participation. While some studies focused on crop market participation, others focused on livestock market participation (Balagtas, Coulibaly, Jabbar and Negassa, 2007; Ndoro, Mudhara and Chimonyo, 2014). A growing stream of authors also studied market participation by considering a single crop (Okoboi, 2011; Sigei, Bett, Kibet and Mutai, 2013, Zamasiya, Mango, Nyikahadzoi and Siziba, 2014).

According to the World Bank (2008) and several authors such as Leykun and Jemma, 2014; Berhanu and Moti, 2010, Pingali and Rosegrant, 1995, commercial transformation of subsistence agriculture is a sine qua non for growth and development of many agricultural dependent developing countries. Berhanu *et al.* (2010) opined that, sustainable household food security and welfare also requires commercial transformation of subsistence agriculture. To strengthen their opinion on the significance of commercialization on economic growth and development of subsistence agriculture, Berhanu *et al.* (2010) developed a framework based on 5 arguments namely, specialization argument, induced demand argument, efficient resource utilization argument, extraction of funds for industrial development and addressing food insecurity argument. However, Braun (1995) on his part cautioned that, while commercialization by itself rarely has adverse consequences on household welfare, commercialization combined with failures of institutions, policies, or markets can be damaging.

In this study, we focused on cassava farmers who participated in processed cassava market. Therefore, while market participation was defined as a dichotomous response variable taking 1 if a cassava farmer sold processed cassava and 0 otherwise, the level of market participation in processed cassava market by cassava farmers was defined as the quantity of processed cassava output sold.

2.6 Analytical Review

2.6.1 Sustainable livelihood framework

Livelihoods are about people, so livelihoods analysis is based on understanding how people make their living. It uses participatory methods, and serves as a framework to decide which participatory livelihoods assessment methods to use at the appropriate time, and how to frame key questions. The livelihood approach recognizes that there are important differences among households in a given community, and among individuals who make up the household. Differentiation may involve relative well-being or it may focus on issues such as gender, age or ethnicity. The approach enables outsiders to better appreciate these differences, and to design processes that can cope with complexity and diversity. It encourages holistic analysis, with attention to identifying factors inside and outside households that have beneficial or negative impacts on livelihoods.

Successful poverty reduction strategies must address a whole range of issues. There are many possible interventions, but resources are limited. Therefore, it is crucial to select and target interventions in ways that will have the greatest impact and reduce poverty and vulnerability for most people. Reflective practice must apply both to the 'implementing agent' and the community/households involved. Engaging the community in an ongoing discussion and analysis of changes in their livelihoods over time helps make people at all levels more aware of potentials and linkages. Livelihoods analysis can provide a useful framework for monitoring the impacts of development initiatives and can pinpoint unintended consequences.

This study adopts a sustainable farmer livelihood framework approach adapted from Dontsop *et al.* (2013) to assess the linkages among market participation, technical efficiency and rural poverty of small scale cassava farmers in Nigeria. Like in every society, individual households in Nigeria are endowed with infrastructural (road, electricity, health centers, storage facilities, etc.), natural (land, water, wildlife, and biodiversity), human (skills, aptitudes, knowledge, experience, ability to labour, and good health), financial and social capital (savings, credits, remittances, pensions, transport, shelter, water, energy, communications, networks, groups, trust, mutual understanding, shared values, and access to institutions) resources which constitute the constraints on which they maximize their well-being. These resources are affected by exogenous factors such as agro-climatic conditions (drought, rainfall, etc.), pests and diseases which hinder their change in technology through the use of improved varieties which have better characteristics (drought tolerance, high yield, weed competitiveness, etc.).

Farmers believe that adopting new technologies and methods of production would increase their efficiency and productivity which in turn would generate enough yields for consumption and marketable surplus and therefore anticipate better welfare through market participation. Income increased as a result of market participation (selling of a fraction of output produced) will further enable them to acquire more technology and complementary inputs in order to sustainably increase their productivity and welfare (Figure 1).

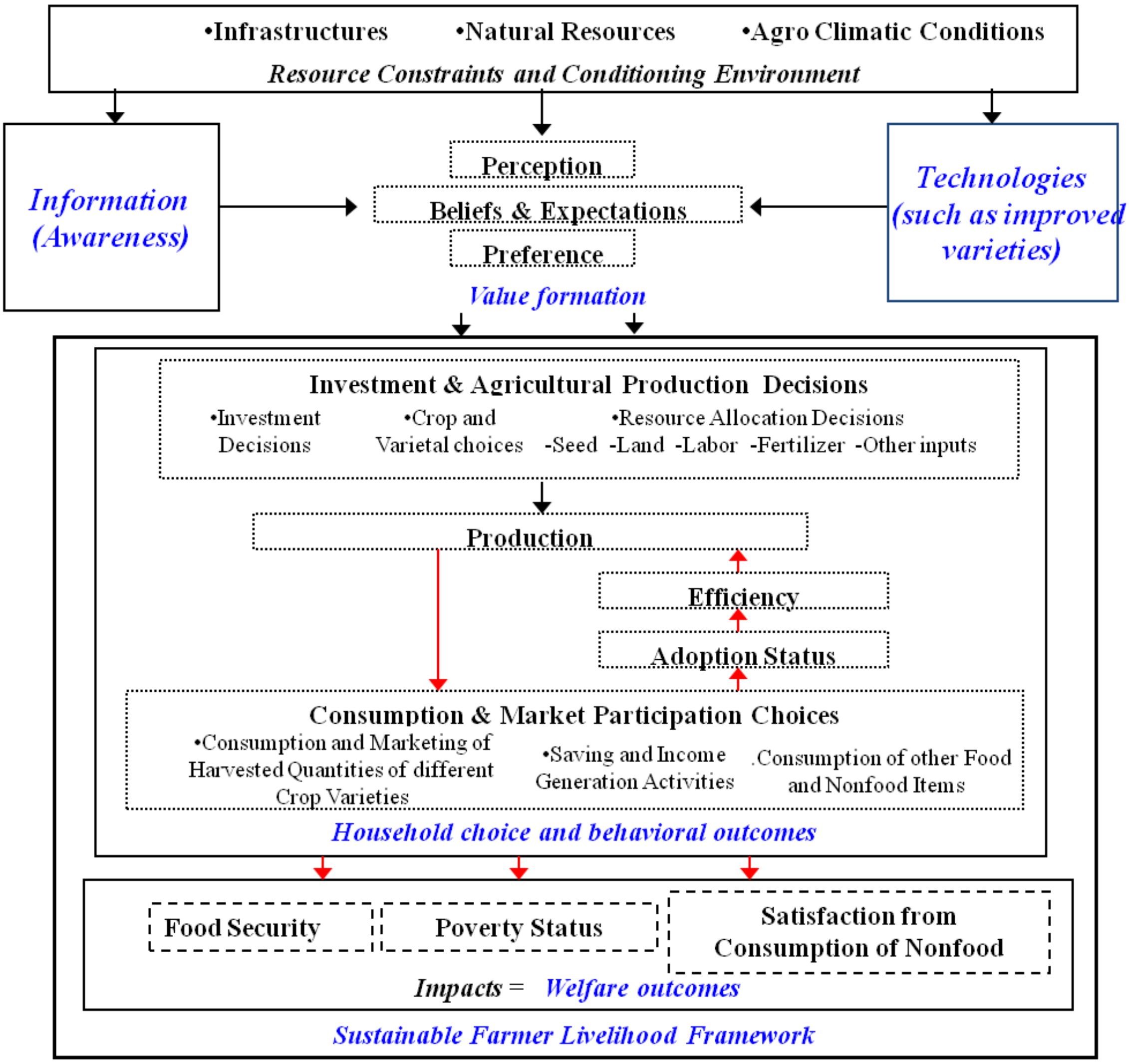

Figure 2.1: Sustainable Farmer livelihood Framework
Source: Adapted from Targeting Agricultural Research for Development Investments in Cassava and Yam Production Systems in Africa: Evidence from Nigeria (Dontsop *et al.*, 2013).

2.6.2 Previous Studies on determinants of technical efficiency

Coelli and Battese (1996), and Bravo-Ureta and Pinheiro (1993) identify a number of variables that may influence Technical Efficiency (*TE*) in agriculture. Gorton and Davidova (2004) suggest that these variables should be classified into two major groups: (i) human capital and (ii) structural factors. Human capital includes variables such as formal and informal education, literacy, agricultural experience, training and farmer's age. The structural factors include family income, family size, access to credit, land tenure status, gender composition of the labour force, off-farm employment and environmental variables. A recent and comprehensive survey of *TE* studies in agriculture can be found in Bravo-Ureta *et al* (2007).

Oyewo and Isaac (2011) studied the *TE* of maize production in Oyo state using cross-sectional data. Although the farmers were found to be averagely technically efficiency with an estimated average efficiency of 0.96, the empirical results revealed that only two variables were found to be significantly reducing technical inefficiency. Land size and seed significantly reduced technical inefficiency at 10 and 1% respectively.

Amaza and Maurice (2005) conducted a study on the identification of factors affecting technical efficiency in rice-based production system among Fadama farmers in Adamawa, Nigeria. Using cross-sectional data, their results revealed that education and farming experience significantly reduced technical inefficiency.

2.6.3 Stochastic frontier approach to production efficiency measurement

The measurement of productive efficiency empirically is dated back to Farrell (1957). Using programming techniques, Farrell showed how to define cost efficiency and how it can be decomposed into its technical and allocative components. His method shows how production frontiers can be used to assess the efficiency of firms. Since then, analysis of production frontiers has evolved quite well.

2.6.4 Translog stochastic frontier production function

Stochastic production frontier models were introduced by Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977). Since then, stochastic frontier models have become a popular sub-field in econometrics. Suppose that a producer has a production function $f(z_i, \beta)$ in a world without error or inefficiency, the ith firm would produce $q_i = f(z_i, \beta)$. Stochastic frontier analysis assumes that each firm potentially produces less than it might due to a degree of inefficiency. Specifically, $q_i = f(z_i, \beta)\xi_i$.

Where ξ_i is the level of efficiency for firm i; ξ_i must be in the interval $(0,1]$. $If\ \xi_i = 1$, the firm is achieving the optimal output with the technology embodied in the production function $f(z_i, \beta)$. When $\xi_i < 1$, the firm is not making the most of the inputs z_i given the technology embodied in the production function $f(z_i, \beta)$. Because the output is assumed to be strictly positive $(that\ is, q_i > 0)$, the degree of technical efficiency is assumed to be strictly positive $(that\ is, \xi_i > 0)$. Output is also assumed to be subjected to random shocks, implying that $q_i = f(z_i, \beta)\xi_i exp(v_i)$. The translog form of $f(z_i, \beta)$ in an n-input production process can be expressed as

$$f(z_i, \beta) = f(z_i, \ldots . z_n; \beta) = y_i = \alpha_0 \prod_{i=1}^{n} z_i^{\alpha_i} \prod_{i=1}^{n} z_i^{\frac{1}{2}\left[\sum_{j=1}^{n} \beta_{ij} lnz_j\right]} \xi_i exp(v_i)$$

$y_i =$ Output;

$\alpha_0 =$ Efficiency parameter;

$z_j =$ Input; and

α_i and β_{ij} = Unknown parameters.

Taking the natural log from both sides, one obtain a more familiar form

$$lny_i = ln\alpha_0 + \sum_{i=1}^{n} \alpha_i lnz_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \beta_{ij} lnz_i lnz_j + ln\xi_i + v_i$$

Assuming that there are k inputs and that the production function is linear in logs, defining $u_i = -ln(\xi_i)$ yields. Then

$$lny_i = ln\alpha_0 + \sum_{i=1}^{n} \alpha_i lnz_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \beta_{ij} lnz_i lnz_j + v_i - u_i$$

Because u_i is subtracted from $ln\ (y_i)$, restricting $u_i \geq 0$ implies that $0 < \xi_i \leq 1$, as specified above. The estimation of the translog stochastic frontier model will depend on the distributional assumption of u_i (Truncated-normal, exponential and half-normal).

2.6.5 Definition and measurement of poverty

Poverty refers to a situation whereby households or individuals do not possess enough resources or abilities to meet their current basic needs (Aline et *al.*, 1996). This definition is based on a comparison of individuals' income, consumption, education, or other attributes with some defined threshold below which individuals are considered as being poor in that particular attribute.

Three ingredients are required in computing a poverty measure. First, one has to choose the relevant dimension and indicator of well-being. Second, one has to select a poverty line, that is, a threshold below which a given household or individual will be classified as poor. Finally, one has to select a poverty measure to be used for reporting for the population as a whole or for a population subgroup only.

Poverty can be analyzed using either objective or subjective (qualitative) dimensions. When estimating poverty using objective (monetary) measures, one may have a choice between using income or consumption as the indicator of well-being. Most analysts argue that, provided that information on consumption obtained from a household survey is detailed enough, consumption expenditure will be a better indicator of poverty measurement than income. In effect, according to Aline et *al*. (1996) in poor agrarian economies, incomes for rural households may fluctuate during the year base to the harvest cycle. In urban economies with large informal sectors, income flows also may be erratic. This implies a potential difficulty for households in correctly recalling their income, in which case the information on income derived from the survey may be of low quality. In estimating agrarian income, an additional difficulty in estimating income consists in excluding the inputs purchased for agricultural production from the farmer's revenues. Finally, large shares of income are not monetized if households consume their own production or exchange it for other goods, and it might be difficult to price these. Estimating consumption has its own difficulties, but it may be more reliable if the consumption module in the household survey is well designed. Many alternative measures of poverty exist but the most common are poverty incidence, poverty gap and poverty severity.

2.6.5.1 Incidence of poverty (Headcount index)

This is the share of the population whose income or consumption is below the poverty line, that is, the share of the population that cannot afford to buy a basic basket of goods and services.

2.6.5.2 Depth of poverty (Poverty gap)

This provides information regarding how far off households are from the poverty line. This measure captures the mean aggregate income or consumption short- fall relative to the poverty line across the whole population.

2.6.5.3 Poverty severity (Squared poverty gap)

This takes into account not only the distance separating the poor from the poverty line (the poverty gap), but also the inequality among the poor. That is, a higher weight is placed on those households further away from the poverty line.

2.6.6 One-way analysis of variance (ANOVA)

Unlike t-test - looks at quantitative outcomes with a categorical explanatory variable that has only two levels - One-way Anova examines equality of population means for a quantitative outcome and a single categorical explanatory variable with any number of levels.

2.6.6.1 One-way Anova and statistical hypotheses

One-way ANOVA is a statistical method of determining whether there are any significant differences between the means of three or more independent groups. It is appropriate when the following model holds. We have a single treatment (cassava market participation system) with, say, k levels (fresh root cassava market, cassava ships market etc.). There is a population of interest for which there is a true quantitative outcome (economic efficiency) for each of the k levels of treatment. The population outcomes for each group have mean parameters that we can label μ_1 through μ_k with no restrictions on the pattern of means. The population variances for the outcome for each of the k groups defined by the levels of the explanatory variable are assumed to all have the same value, usually called σ^2, with no restriction other than that $\sigma^2 > 0$. For treatment i, the distribution of the outcome is assumed to follow a Normal distribution with mean $\mu_i$and variance σ^2, often written $N(\mu_i, \sigma^2)$.

The model assumes that the true deviations of observations from their corresponding group mean parameters, called the "errors", are independent. Subjects are randomly selected from the population, and then randomly assigned to exactly one treatment each. The number of subjects assigned to treatment i (where $1 \leq i \leq k$) is called n_i if it differs between treatments or just n if all of the treatments have the same number of subjects. For convenience, let's define $N = \sum_{i=1}^{k} n_i$ which is the total sample size (Σ=Summation). The null hypothesis for one-way Anova can be written as $H_0 = \mu_1 = \mu_2 = \cdots = \mu_k$ which state that all the population means are equal without restricting what the common value is. The alternative hypothesis is can be written as H_A: the population means are not equal. Under the null hypothesis the F-statistic is defined as

$$F = \frac{MS_{between}}{MS_{within}}$$

$MS_{between} =$ Mean square between groups = $\frac{\sum_{i=1}^{k} n_i(\bar{Y}_i - \bar{\bar{Y}})^2}{k-1}$

$MS_{within} =$ Mean square within groups = $\frac{SS_{within}}{df_{within}}$

$SS_{within} =$ Sum of square within groups = $\sum_{j=}^{n_i}(Y_{ij} - \bar{Y}_i)^2$

$df_{within} =$ Degree of freedom within groups = $n_i - 1$

$k =$ Number of categories of groups

$n_i =$ Number of small farmers within the i^{th} category

$\bar{Y}_i =$ Mean value of the outcome variable within the i^{th} category

$Y_{ij} =$ Value of the outcome variable for the j^{th} within the i^{th} category

$\bar{\bar{Y}} =$ Grand or total mean

Under the null hypothesis, if the f-statistic is greater than the tabulated one, then the null hypothesis is rejected otherwise accepted. If the above assumptions are satisfied then a causal relation can be made otherwise any significant difference can only be regarded as presence of association between the treatment variable and the outcome of interest.

2.6.7 Modeling binary response

In a binary response model, the dependent variable y_i takes on only two values, 0 and 1. Let p_i denote the probability that $y_i = 1$ conditional on the information set Ω_i, which consists of exogenous and predetermined variables (X). From the theory of probability, it can be demonstrated that $E(y_i|\Omega_i) = p_i = \beta_0 + X\beta + \varepsilon$. This model is called in the literature linear probability model (*LPM*) and can be estimated by ordinary least square (OLS) method. However, the model is found to possess a number of lapses. Firstly, Although OLS does not require the ε to be normally distributed, it is assumed so for the purpose of statistical inference. But the assumption of normality of ε is not tenable for the LPM because like y_i, the disturbance ε takes on only two values; that is, they follow a Bernoulli distribution. Secondly, ε is heteroscedastic in LPM since the variance of a Bernoulli random variable is a function of its mean which is p_i. Thirdly, p_i is not always limited within the interval 0 and 1. The non-normality, the heteroscedasticity of the disturbance term and the failure of p_i to be bounded by 0 and 1 are not insurmountable because it is found that with proper transformation all the aforementioned problems can be solved. The fundamental concerned of the LPM is that p_i increases linearly as X increases; that is, the marginal effect of X remains constant throughout. Thus an adequate model for binary response must ensure that p_i lies between 0 and 1, and is a nonlinear function of X.

Probit and logit models are the two dominant binary response models found in literature that possess the qualities of a good model for binary response mentioned above. Both models ensure that p_i lies between 0 and 1 by adopting the following specification: $p_i = E(y_i|\Omega_i) = F(z)$ Where $z =$ index function and $F()$ is a transformation function. For probit the model, $F(z) =$ cumulative normal distribution function and for the logit model $F(z) =$ cumulative logistic distribution function. In this research work, we will focus our attention on the logit because it is easier to interpret than the probit.

2.6.7.1 Logit model

In statistics, logistic regression, or logit regression, or logit model is a direct probability model that was developed by statistician by D.R. Cox in 1958. It is a model relating a dichotomous dependent variable to one or more independent variables. The logit model is very similar to the probit model. The only difference is $F(X\beta)$ which a logistic function.

The model can be written as

$F(z) = \frac{1}{1+e^{-z}} = \frac{e^z}{1+e^z}$ (Logistic function)

The logit model can be derived by assuming that

$L_i = ln\left(\frac{p_i}{1-p_i}\right) = z = \beta_0 + \beta X + u$ (Logistic model)

Which means that the logarithm of the odds (that is the ratio of the probability of success to that of failure of observing a characteristic of interest or phenomenon like poverty) is equal to $X\beta$. Solving for p_i, we find that

$p_i = \frac{exp(z)}{1+exp(z)} = \frac{1}{1+exp(-z)}$

The β in the logit model is estimated by the method of maximum likelihood.

2.6.8 Modeling limited outcomes: Censored regression models

Censored regression models are generally applied when the dependent variable is partly continuous but has positive probability mass at one or more points (Wooldridge, 2002). They are a class of models where some observations have constant values in the outcome variable representing either the lower or upper limit of the values taken by the outcome variable. In order words, these models fit a sample data in which the regressand is either unobservable (latent outcome) or takes on the value zero (corner solution outcome). Such samples are called censored samples. Assuming that the objective of the model is to estimate the conditional expectation of the regressand, ordinary least square (OLS) estimators are biased and inconsistent because the conditional expectation of the limited dependent variable is no longer a linear function of a given set of covariates (Wooldridge, 2002). If the regression is carried out on the uncensored sample only the parameters are inconsistent and the inference is impossible. Further, predicted values of the regressand can be negative (Wooldridge, 2009).

2.6.8.1 Exponential regression model

An exponential regression model is the process of finding the equation of the exponential function that fits best for a set of data. Exponential regression model ensures that the dependent variable is positive. If the regressand is partially unobservable, the parameters are unbiased but the variance of the model is likely to be heteroscedastic (Wooldridge, 2002). Even though heteroscedasticity exponential regression models are available, the results are usually not reliable. If on the other hand the explained variable is rather a corner solution outcome the model is not estimable since the logarithm of zero value does not exist.

2.6.8.2 Tobit model

The Tobit regression model, also called a censored regression model, is designed to estimate linear relationships between variables when there is either left or right censoring in the dependent variable (also known as censoring from below and above respectively.

Tobit model is a better model compare to the exponential regression model in the sense that parameters estimation is based on maximum likelihood techniques. However, coefficient estimates in Tobit model are likely to be biased and inconsistent in presence of misspecification, non-normality and heteroscedasticity in the latent regression model. In corner solution framework an important limitation of the standard Tobit model (Wooldridge, 2009) is that it assumes a single mechanism between the "participation decision" ($y = 0$ versus $y > 0$) and the "amount decision" (what is y if $y > 0$). Moreover in a Tobit model the partial effect of a continuous variable on $p(y = 1|X)$ and $E(y|X, y > 0)$ are of the same sign. So, it is impossible for a covariate to have a positive effect on $p(y = 1|X)$ and a negative effect on $E(y|X, y > 0)$. A similar comment holds for discrete independent variables. Moreover, if the effect of say, x_1 is twice that of x_2 in the "participation decision" equation, the same must apply in the "amount decision" equation. Two-part models allow different mechanisms for the participation and the amount decisions under specific assumptions.

2.6.8.3 Cragg's double hurdle model

It is an alternative to the Tobit model where the censoring of the outcome variable is assumed to be explained by the choice of the observations under study. Cragg (1971) Hurdle model allows the choice equation and the quantity equation to be estimated separately. Under the conditional mean independence assumption (CIA), the choice variable is assumed to follow a probit model. Further, the partially observable outcome of interest has a truncated normal distribution with parameters that vary freely from those in the probit equation. Precisely, under the CIA, TNH model is a system of equations where a Probit model is estimated in the first equation using maximum likelihood. In the second equation a Tobit model is estimated. However the CIA is almost impossible to be tested meaning that the results should be taken with some caution.

2.6.8.4 Heckman selection model

It is an alternative to the Cragg's double model where the outcome variable is not censored but rather contains missing values due to self-selection. Random sample is one of the crucial assumptions made before conducting any scientific research. In practice, the availability of random sample is not always guaranteed because of the way some economic data sets are collected, often because of the behavior of the units being sampled, including non-response on survey questions and attrition from social programs. An interesting fact to remember is that sample selection is a problem only when the population from which the sample is drawn is well identified (Wooldridge, 2002).

According to Wooldridge (2002), sample selection bias also called incidental truncation (quantity sold data would be missing for some cassava farmers) is likely to be present in a model that aims at estimating the quantity of cassava sold by all the cassava producers in Kaduna State. It is believed that an unobservable variable should be able to explain the reason of the missing data and that if the effect of such variable is not neutralized then there could be endogeneity particularly if the variable is correlated with one or many of the included independent variables in the model. The incidental truncation in this example has a strong self-selection component: people self-select into market participation, so whether or not we observe quantity sold depends on an individual's decision. The important point to note here is that we must account for the nonrandom nature of the sample we have for estimating the factors affecting the quantity of cassava sold.

In Heckman model unlike the hurdle models, the participation decision and the outcome decision are allowed to be dependent conditional on a set of covariates. This model is a flexible model that properly addresses sample selection issue (Wooldridge, 2009). It can poorly estimates the parameters if the same covariates are used in both the choice and the quantity equations. The best method is to ensure that the participation equation contains all the covariates included in the amount equation. However, a control variable needs to be included in the amount equation. Such variable is technically called an Inverse of Mills Ratio (IMR). Heckman model also called Heckit can be presented as follows:

In the first step a probit model is estimated.

$w = [X\gamma + v > 0]$ (Participation decision equation)

In the second step an exponential regression model including a control variable is estimated based on the uncensored sample.

$E(\log(y)|X, y > 0) = Z\beta + \rho\sigma\lambda(X\gamma) + u$ (Amount decision equation)

Where $\lambda(X\gamma) =$ IMR and $\rho = cov(v, u)$

If $\rho = 0$ then (1) and (2) are independent and Tobit model can be used.

2.6.9 Modeling impact

Impact evaluation of a programme is an ex-post evaluation destined in particular to determine whether a given programme is effective or not. Theoretically, the problem of programme evaluation has been defined by Rubin (1974) as the causal effect of the programme. A programme is effective or has had an impact if one can prove that it has permitted to improve the state of the beneficiary in comparison to an alternative situation in the absence of the programme (counterfactual state). To ensure the methodological rigor, an impact evaluation ought to estimate the counterfactual effects. That is what would have happened to the treatment group (e.g. market participants) in the absence of the intervention (e.g. participation in market). In other words, the empirical difficulty in impact evaluation under the potential framework resides in the estimation of the counterfactual. However, it is obviously not possible to observe a beneficiary in the situation where he or she is not in the programme. It is believed that if individuals who did not participate are similar to those who did with respect to their observed characteristics, then these two groups could be compared so that the observed difference would be an unbiased and consistent estimate of the causal effect of the programme.

Random assignment is viewed as the most robust evaluation approach (Burtless, 1995). Properly carried out, random assignment creates a control group comprising of individuals with identical distribution of observable and unobservable characteristics to those in the treatment group. However, the problem of randomization that is problems arising during the implementation of the experiment itself may alter the framework within which a program operates.

Despite the potential drawbacks associated with random assignment, if correctly administered, it remains by far the most robust means of estimating a treatment effect such as the causal effect of market participation on poverty. However, many methods are carried out using non-experimental data but make some assumptions concerning the nature of potential selection bias because this is crucial to developing appropriate models to determine program impacts. These methods include: (i) the "before and after" method, where post data on outcomes are compared with the baseline data of the same outcomes; (ii) the "with and without" method, where two different groups of individuals (with treatment and without treatment) are compared ex-post based on some defined outcomes; (iii) the Instrumental Variable (*IV*) method, relies on the presence of additional treatment, the so-called instruments; (iv) the Regression Discontinuity method which has recently been revived in the economics literature through work by Klaauw (2002), Lee (2001); (v) the Difference-in-Differences estimator method, which relies in the presence of additional data in the form of samples of treated and control units before and after the treatment; (vi) the Propensity Score methods and finally the Local Average Treatment Effect (*LATE*) which combines the Propensity Score Matching (*PSM*) and the Instrumental Variable on the subpopulation of compliers (who comply with their assignment and would have complied with the alternative assignment).

2.6.9.1 Rubin causal model (RCM) framework

The Rubin Causal Model with its potential outcomes notation offers a convenient framework for defining causal quantities and deriving corresponding estimators (Rubin, 1974, 1978). Estimating *ATEs* has become important in the program evaluation literature, such as in the evaluation of job training programs. Originally, the binary indicators represented medical treatment or program participation, but the methods are applicable when the explanatory variable of interest is any binary variable (Wooldridge, 2002). RCM has the advantage that it emphasizes the counterfactual situations of the units in the treatment or control condition. That is, what would the outcome of the treated units have been had they not been treated; and what would the outcome of the untreated have been had they been treated. These two counterfactual situations define the missing outcomes for the treatment and control units, respectively. Matching techniques can be broadly considered as methods for imputing these missing counterfactual outcomes either at the individual level (individual case matching) or at the group level.

Under the potential outcome framework developed by Rubin (1974), each farm household has ex-ante two potential outcomes: an outcome when it participates in market that we denote by y_1 and an outcome when it does not participate in market that we denote by y_0. If we let the binary outcome variable w stands for market participation status, with $w = 1$ meaning participation and $w = 0$ meaning non-participation, we can write the observed outcome y of any farm household as a function of the two potential outcomes:

$$y = wy_1 + (1 - w)y_0$$

$$y = y_0 + w(y_1 - y_0) \quad \text{.......} \quad (1)$$

For any farm household, the causal effect (impact) of market participation on an observed outcome y is simply the difference between its two potential outcomes $(y_1 - y_0)$. But because the realizations of the two potential outcomes are mutually exclusive for any household (i.e. only one of the two potential outcomes can be observed ex-post), it is impossible to measure the individual effect of market participation on any given household. However, one can estimate the mean effect of market participation on a population of households. Such a population parameter is called the Average Treatment Effect (ATE) in the literature (Imbens, and Wooldridge, 2002). One can also estimate the mean effect of market participation on the sub-population of market participants - $E(y_1 - y_0|w = 1)$ - which is called the Average Treatment Effect on the treated and is usually denoted by ATE_1 (or ATT). The Average Treatment Effect on the untreated - $E(y_1 - y_0|w = 0)$denoted by ATE_0 is another population parameter that can be defined and estimated.

2.6.9.2 Average treatment effect (ATE) models

Average treatment effect is a measure used to compare treatments (or interventions) in randomized experiments, evaluation of policy interventions, and medical trials. It is a special case of an average partial effect (APE). It is a APE for a binary explanatory variable. It is the expected causal effect of treatment on a randomly drawn person from a population (Wooldridge, 2002). The theoretical framework under which this quantity is estimated in the literature in called the counterfactual framework. Globally, there are three assumptions in the counterfactual framework under which the various treatment effects can be identified: the mean independence assumption (MIA), the conditional mean independence assumption (CIA) and the instrumental variable assumption (IVA). However, the MIA is difficult to be satisfied if not impossible in social sciences since is it is quite infeasible to randomize cases across treatment categories and this is often due to practical and ethic reasons. If at all randomization was possible therefore, difference in mean estimator would be an unbiased, consistent and asymptotically normal estimator of the various treatment effects.

2.6.9.3 Kitchen sink regression (KSR) model

It is a multiple regression model designed to estimate the effect of a treatment, policy or intervention in observational studies by controlling for self-selection through interaction of the treatment variable and the socio-economic factors assumed to explain the choice of the observations. Let x denoting a vector of observed covariates and (y_0, y_1, w, x) a vector representing the characteristics of an individual in an independent, identically distributed sample drawn from the population of interest. Where y_0 and y_1 are the potential levels of technical efficiency under market and non-market participation system respectively.

Under the Conditional mean Independence Assumption (*CIA*) alongside equation (9) the following can be deduced:

$E(y|x,w) = E(y_0|x,w) + w[E(y_1|x,w) - E(y_0|x,w)]$

$E(y|x,w=1) = E(y_1|x,w=1)$ and $E(y|x,w=0) = E(y_0|x,w=0)$

Then, $ATE\ (x) = E(y_1|x) - E(y_0|x)$

Let's decompose the potential outcomes as follows:

$y_0 = \mu_0 + v_0$ ………………………………………………………….. (2)

$y_1 = \mu_1 + v_1,$ ………………………………………………………….. (3)

Where v_0 and v_1 represent the stochastic parts of y_0 and y_1 respectively.

Taking the expectation conditional on x and w in both sides, we have:

$E(y_0|x,w) = \mu_0$

$E(y_1|x,w) = \mu_1$

Where

$E(v_0|x) = E(v_1|x) = 0$. It can be deduced that

$\mu_1 - \mu_0 = E(y_1|x,w) - E(y_0|x,w)$

$\mu_1 - \mu_0 = E(y_1|x) - E(y_0|x)$

$\mu_1 - \mu_0 = E(y_1 - y_0|x)$

$\mu_1 - \mu_0 = ATE(x)$ ………………………………………………………. (4)

Plugging (2) and (3) into equation (1) gives:

$y = \mu_0 + (\mu_1 - \mu_0)w + v_0 + w(v_1 - v_0)$ ……………...…............….... (5)

This is a simple example of a switching regression model, where the outcome equations depend on the regime (market participation status in this case).

Taking the expectation of y in the equation (5), conditional on w and x gives:

$E(y|x, w) = \mu_0 + (\mu_1 - \mu_0)w + E(v_0|w, x) + E(v_1 - v_0|w, x)w$

If $w \perp (y_1, y_0)$, then

$E(y|x, w) = \mu_0 + E(\mu_1 - \mu_0|x)w + E(v_0|x) + E(v_1 - v_0|x)w$

$E(y|x, w) = \mu_0 + E(\mu_1 - \mu_0|x)w + E(v_0|x) + wE[(v_1|x) - E(v_0|x)]$

$E(y|x, w) = \mu_0 + \alpha w + g_0(x) + w[g_1(x) - g_0(x)]$……………...…... (6)

Where $\alpha = ATE,\ g_1(x) \equiv E(v_1|x)$ and $g_0(x) \equiv E(v_0|x)$

To operationalize equation (6) in a parametric framework, we would replace $g_1(.)$ and $g_0(.)$ with parametric functions of x; typically, these would be linear in parameters.

For notational simplicity, assume that these are both linear in x. Then, we can write equation (14) as follows:

$E(y|w, x) = \mu_0 + \alpha w + x\beta_0 + \delta w.[x - \varphi]$ ……………………………. (7)

Equation (7) in impact evaluation literature is called a kitchen sink regression model (Wooldridge, 2009).

μ_0, α, β_0, δ and $\varphi \equiv E(x)$ are unknown parameters to be estimated. Note that the control functions that guard against possible self-selection bias (overt and hidden) involve not just the x elements, but also interactions of the covariates with the treatment variable. If desired, we can be selective about which elements of x we want to interact with w_i. Adding functions of x, such as squares or logarithms, at both level terms and interactions, is simple, provided we demean any functions before constructing the interactions.

If the conditional mean independence assumption is satisfied then equation (7) consistently estimates α(Average Treatment Effect). Because regression (7) consistently estimates δ , we can also study how the ATE given x , that is, $ATE(x) = E(y_1 - y_0|x)$changes with elements of x. In particular, for any x in the valid range,

$$A\hat{T}E(x) = \hat{\alpha} + (x - \bar{x})\hat{\delta} \quad \text{………………………...………………….…… (8)}$$

The above equation is a saturated model where dummy variables are defined for each possible outcome on x and are used in place of x.

$A\hat{T}E_1$ and $A\hat{T}E_0$ will be estimated by averaging $ATE(x)$ over the sub-samples of treated and untreated cassava farmers respectively from equation (7).

Using different auxiliary assumptions, Rosenbaum and Rubin (1983, Corollary 4.3) suggest a more general version of regression (15) for estimating *ATE*:

$$E(y|w,x) = \mu_0 + \alpha w + \hat{p}_i + \delta w.\left[\hat{p}_i - \bar{\hat{p}}_i\right] \quad \text{…………………….………. (9)}$$

Where

$\alpha = ATE$ = causal effect (impact) of w on $E(y|w,x)$

$\hat{p}_i =$ Expected propensity score

$\bar{\hat{p}}_i =$ Mean propensity score

Note: The remaining parameters and variables are defined as above.

2.6.9.4 Propensity score nearest neighbor matching model

It is a statistical matching technique that attempts to estimate the effect of a treatment, policy, or intervention by accounting for the covariates that predict the receiving the treatment. All starts with the estimation of a propensity score. Propensity score is defined by Rosenbaum and Rubin (1983) as the conditional probability of receiving a treatment (e.g. participating in market) given pretreatment characteristics:

$p(x) \equiv p(D = 1|X) = E(D|X)$

$D = \{0,1\}$ the indicator to exposure to treatment and X is is the multidimensional vector of the pretreatment characteristics. Rosenbaum and Rubin (1983), show that if the exposure to treatment is random within cells defined by X, it is also random within cells defined by the values of the one-dimensional variable $p(x)$. As a result, given a population of units denoted by *i*, if the propensity score $p(x)$ is known, then the Average effect of Treatment on the Treated ATE_1 can be estimated as follows:

$$ATE_1 \equiv E\{y_{1i} - y_{0i}|D = 1, p(x)\} = E(\{y_{1i}|D = 1, p(x)\} - \{y_{0i}|D = 0, p(x)\}|D = 1)$$

Where the outer expectation is over the distribution of $(X_i|D = 1)$, y_{1i} and $y_{0i}$are the potential outcomes in the two counterfactual situations of (respectively) treatment and no treatment. Formally, the following two hypotheses are needed to identify *ATEs*.

Lemma 1: Balancing of pretreatment variables given the propensity score. If $p(x)$ is the propensity score, then $D \perp X|p(x)$ That is D is independent of X conditional on the propensity score. Lemma 2**:** Unconfoundedness given the propensity score. Suppose that assignment to treatment is unconfounded ($y_{1i}, y_{0i} \perp D|X$), that is, the potential outcomes (y_{1i}, y_{0i}) are independent of the treatment variable conditional on X .Then by construction, assignment to treatment is unconfounded given the propensity score. $y_{1i}, y_{0i} \perp D|p(x)$ That is the potential outcomes (y_{1i}, y_{0i}) are independent of the treatment variable conditional on $p(x)$. If the Balancing Hypothesis of Lemma 1 is satisfied, observations with the same propensity score must have the same distribution of observable and unobservable characteristics independently of treatment status. In other words, for a given propensity score, exposure to treatment is random and therefore treated and control units should be on average observationally identical.

The program *pscore.ado* in the statistical package Stata 12 estimates the propensity score and tests the Balancing Hypothesis (Lemma 1) according to the following steps: 1) A probit or logit model is fitted using the following specification $p(X_i|D = 1) = \emptyset\{h(X_i)\}$, Where $\emptyset$ denotes the normal (logistic) cumulative density function (CDF) and $h(X_i)$ is a starting specification that includes all the covariates as linear terms without interactions or higher order terms. 2) The sample is split into k equally spaced intervals of the propensity score, where k is determined by the user and the default is 5. 3) Within each interval, a test that the means of each characteristic do not differ between treated and control units is carried out. This is a necessary condition for the Balancing property to hold. If the means of one or more characteristics differ from others, then that means a less parsimonious specification of logit or probit model is required. The process continues until, in all intervals, the average propensity score of treated and control units does not differ.

An estimation of the propensity score is not enough to identify the various ATEs of interest. The reason is that the probability of observing two units with exactly the same value of the propensity score is in principle zero since $p(x)$ is a continuous variable. Various algorithms have been proposed in the literature to overcome this problem, and four of the most widely used are Nearest-Neighbor Matching, Radius Matching, Kernel Matching, and Stratification Matching.

2.6.10 Empirical models for market participation level

Censored regression and corner solution outcome models such standard Tobit model and its generalizations have often been used in the literature of market participation. Standard Tobit model was initially developed to model variations either in a censored dependent variable or corner solution outcomes. Double hurdle, Cragg double hurdle and Heckman sample selection models were later developed as generalizations of the type I (standard) Tobit regression model through the work of a number of researchers including Goldberger (1964) and Duan *et al.* (1983). Each of these generalizations shares one unifying characteristic which is that they are all bivariate alternatives to the Tobit model. That is, they provide separate estimates for the participation decision and the level of participation (Eakins, 2013). How they differ depends on the assumptions underlying the separation of the decision and level of market participation.

2.6.10.1 Exponential regression model

Using primary data on 180 respondents, Agwu, Anyanwu and Mendie (2012) estimated an exponential regression model using OLS method to determine the factors affecting the level of commercialization among smallholder farmers in Abia state, Nigeria. The results of the study showed that none of the crops under study attained a commercialization level of 30%. However, cassava had the highest level followed by maize and sweet potato. Factors such as household size, income, farming experience, farm size, distance to market, membership of society and access to credit were statistically significant in explaining positive variation in the level of commercialization in the study area.

Advantages of the exponential regression model: The exponential regression model is a reasonable model to follow in modeling market participation level since it ensures that positive predicted values are obtained. Furthermore, the parameters of the model are easy to interpret (Wooldridge, 2002).

Disadvantages of the exponential regression model: The first limitation of the approach is that OLS method cannot be applied if the level of commercialization is a corner solution outcome because the logarithm transformation of the level of commercialization will be infeasible due to zero quantity sold for a subset of the sample and therefore the parameters of the model should be estimated using Non-linear Least Square (NLS) methods such as maximum likelihood estimators which are more complex than OLS method. However, according to Wooldridge (2002), even though robust methods such as delta and bootstrap can be used to correct the heteroscedastic error term obtained through NLS methods, we would not be able to estimate the effects of the covariates of the model on important features of the distribution of HCI such $E(y|X, Y > 0)$ and $p(y > 0|X)$. Moreover, using only the uncensored data, two complications are induced. First, the OLS parameters are unbiased due to omitted variables (Inverse of mills ratio). Second, the restricted dependent variable is no longer linear in both the variables and the parameters of the model.

2.6.10.2 Tobit regression model

Adenegan, Adepoju, and Nwauwa (2012) employed a Tobit regression model to examine the determinants of market participation of maize farmers in rural Osun State of Nigeria. Using the volume of maize sold as proxy of the level of market participation of maize farmers in the study area, the study revealed that total maize produced, age, years of education, ownership of cultivating equipment, access to non-farm income, belonging to farmers' association, means of information had a positive and significant relationship with the volume of sales while marital status and transportation had a significant but negative effect on the volume of maize sales.

Kirui and Njiraini (2013) employed four nested standard Tobit models with and without interaction and marginal effects respectively to assess the determinants of commercialization among rural poor in Kenya. The based model was estimated without interaction terms. The second model contained interaction effects between gender and participation in collective action initiative. The third model contained interaction effects between gender and use of ICT (mobile phones) and the fourth model contained interaction effects among gender and participation in collective and use of ICT. The findings of the study revealed that farmer-specific factors (gender, ICT use, group member and age), farm-specific factors (output market distance and number of crops produced), and capital endowment factors (education, farming experience, non-farm income and total income) influenced the commercialization process.

Advantages of the Tobit regression model: Tobit model can be used to analyze both censored data and corner solution outcomes. The main advantage of the Tobit model is that compared to OLS regression model using both zero and positive observations, it produces parameters that are unbiased as well as consistent (Wooldridge, 2002; Eakins, 2013). Unlike standard regression models, it permits the estimation of three features of a corner solution outcome: the unconditional expectation, the conditional expectation given positive values of the outcome variable and the probability of observing positive values of the corner solution outcome.

Disadvantages of the Tobit regression model: By transposing the reasoning given by Gronau (1974) and the logic of Wooldridge (2002) to the present study of participation in processed cassava market, we can say that, it makes no sense to set the quantity of processed cassava sold to zero just because we do not observe it (due to non-participation in market). This is also to say that, in standard Tobit model, there is an artificial assignment of zero quantity sold when the actual quantity sold is unobserved. This is often done on based on the assumption that zero quantity sold is an optimal solution to those for whom data are unobserved. According to Wooldridge (2002), assigning zero quantity is arbitrary but necessary only for the derivation of the statistical properties of the standard Tobit model since the variable of interest will now become a corner solution outcome. But, if it can be proven that zero quantity sold actually maximizes the utility of some farmers, then we will fall in the standard Tobit model framework. The complexity of the problem is due to the fact that the “reservation utility” that enables to know whether or not the condition holds through comparison with the perceived utility from market participation is unobserved.

The major limitation of the Tobit model is that the process that leads to the zero quantity is the same process that leads to the positive quantity. In order words, standard Tobit model assumes one mechanism in the determination of the quantity sold which therefore causes the model to be restrictive (Zhang, Huang and Lin, 2006). Technically, the effect of a given covariate on $p(y > 0|X)$ and $E(y|X, y > 0)$ will have the same sign and significance (Wooldridge, 2002; Eakins, 2013; Sigei, Bett, Kibet and Mutai, 2013; Zamasiya, Mango, Nyikahadzoi and Siziba, 2014). Moreover, the model assumes normality and homoscedasticity of the error terms. According to Cameron and Trivedi (2010), the failure of the normality and homoscedasticity assumptions have serious consequences for the estimates of the Tobit model.

We can also adopt the scenario presented by Zhang, Huang and Lin (2006) to uncover another weakness of the standard Tobit model in terms of characterizing, for instance, the two processes underlying processed cassava market participation. Let consider a hypothetical sample of cassava farmers, and suppose that we wish to analyze the dependent variable, “quantity of processed cassava sold”, during some time period. Since this is often zero (arbitrary allocation) but otherwise positive, the Tobit model might be an obvious choice. However, it is not hard to imagine that farmers with lower output harvested might be less likely to process and sell their product, but might have greater processed cassava for sale when higher output is realized. The Tobit model cannot accommodate this possibility.

2.6.10.3 Cragg's double hurdle model

Tufa, Bekele and Zemedu (2013) employed a Cragg's double hurdle model to explore the determinants of smallholder commercialization of horticultural crops in Gemechis District, West Hararghe Zone, Ethiopia. In the first hurdle, a probit model was used to determine factors affecting commercialization decision where a dummy variable indicating whether or not farmers sold horticulture crops during the period of study was regressed on a set of socio-economic factors. In the second hurdle, a truncated regression model was employed to estimate the level of commercialization where a variable representing the value of horticultural crops sold was regressed on the same set of socioeconomic characteristics used in the first hurdle. The study showed that gender, distance to the nearest market and cultivated land were significant factors explaining the decision of commercialization of horticultural crops in the study area. However, educational level of the household head, household size, access to irrigation, cultivated land and distance to the nearest market influenced the level of market participation in horticultural crops in the study area.

Mukundi, Mathenge and Ngigi (2013) used a sample of 150 sweet potato farmers to evaluate the role of collective actions in both the probability to participate in sweet potato market and the quantity of sweet potato sold. Based on a likelihood ratio test, the Cragg's double hurdle model was found to be better than the standard Tobit model and was therefore employed for the analysis. The analysis demonstrated that participation in collective action was significant in increasing both the probability and quantity of sweet potato sold in the study area.

Advantages of the Cragg's double hurdle model: The model is employed exclusively for corner solution outcome and was developed following the inability of the standard

Tobit model to allow covariates to have differing influence and significance on $p(y > 0|X)$ and $E(y|X, y > 0)$. In order words, double hurdle model allows the separation of the process that leads to the decision to participate in market from the decision regarding the level of participation. The model can allow the evaluation of the significance of Tobit model and it is therefore a more flexible model since the Tobit model is regarded as its restricted version (Ibrahim and Srinivasan, 2014). In order words, the standard Tobit model is nested in the Cragg's double hurdle model.

Disadvantages of the Cragg's double hurdle model: Like the Tobit model it assumes that zero level of participation is an optimal solution for the part of the population whose data on the outcome variable of interest is unobserved. The major drawback of this method is that it makes the strong assumption that the errors in the first hurdle are uncorrelated with those in the second hurdle (Wooldridge, 2002; Zhang, Huang and Lin, 2006; Eakins, 2013). Moreover, the model assumes that farmers with positive levels of participation come from a random sample of a population from which they were drawn.

2.6.10.4 Heckman selection model

Zamasiya, Mango, Nyikahadzoi and Siziba (2012) employed the Heckman's probit model with sample selection to firstly, identify the factors affecting farmer's decision to participate in soybean markets and secondly, evaluate the factors that affect the intensity of farmer's participation in soybean market. Five exclusion restrictions namely radio ownership, cell phone ownership, access to extension service, use of inoculants and improved soybean seed varieties, were excluded from the quantity equation to ensure stability of the coefficients. Ownership of cattle and distance to market were found to be positively and significantly related to the level of participation in soybean market.

Sigei, Bett, Kibet and Mutai (2013) used Heckman two-stage model to determine the factors influencing market participation and its extent among small scale Pineapple farmers in Kericho County in Kenya. Variables such as male-headed household, price information, contract marketing, group marketing, marketing experience and vehicle ownership were found to positive and significantly related to the intensity of pineapple market participation.

Advantages of the Heckman selection model: Heckman sample selection model as its name indicates is a model for sample selection and it has nothing to do with the dependent variable being a corner solution outcome (Wooldridge, 2002). It is a model that allows inference even though the sample under study is nonrandom because of incidental truncation, attrition or general nonresponse that leads to missing data. In order words, the model is used in a situation whereby data are missing systematically on a key variable (the dependent variable) for a clearly defined subset of the population of interest as a result of the outcome of another variable (participation decision). In the context of level of market participation, the unobservability of the key variable for a subset of the population has a strong self-selection component: farmers self-select into market participation. Thus, whether or not we observe the quantity sold of the farmers depends on their market participation decision. The model can equally be used even though the dependent variable is a corner solution outcome.

Disadvantages of the Heckman selection model: The limitation of this approach is that the sample selection might be also caused by unobservables in which case a search for one or more instrumental variables will be required. In practice indentifying good instruments is not always an easy task.

Choice of model for market participation level: Based on the review of models of market participation, exponential regression model does not enable the characterization of important features (marginal effects on the probability to participate and expected quantity sold conditional on the decision to participate in market) of the quantity equation which is often of interest. The Tobit model is used only for censored data and corner solution outcomes and assumes a single mechanism in estimating the quantity equation. Cragg's double hurdle, although being a generalization of the standard Tobit and the standard double hurdle models, does not address the problem of sample selection. In the current study, we do not assume that farmers who did not participate in processed cassava market had zero quantity of processed cassava sold, but rather we took it as being unobserved. Based on the later observation, Heckman sample selection model was chosen to examine the factors affecting the level of participation in processed cassava market system because farmers who did not sell processed cassava did so according to a decision they personally made which may have been affected by both observed and unobserved socioeconomic characteristics. In order words, we do not know the actual reason for which they did not sell processed cassava.

2.6.11 Empirical impact models

2.6.11.1 Kitchen sink regression model

Adekambi, Adegbola, Glele, Agli and Tamegnon (2010) employed a Kitchen sink regression model to evaluate the impact of adoption of high yield cassava variety on productivity using 267 randomly selected cassava producers in Benin republic. They found that adoption of improved cassava variety was positively and significantly related to productivity. They equally noted that, besides adoption of improved cassava variety, other factors such as level of education, association membership, use of fertilizer and revenue from cassava obtained from previous farming season were significantly and positively related to productivity.

Advantages of the kitchen sink regression model: Unlike the difference-in-means estimator, average treatment effect (ATE) based on regression methods such as Kitchen sink regression model take care of differences in observed characteristics (overt bias) across the treated and control groups (participants and non-participants) through interaction between the dichotomous treatment variable and the observed set of covariates. It can be used to estimate treatment effects in observational data by regressing the outcome of interest on a set of covariates, including a treatment variable and interactions between the treatment variable and each of the covariates. An advantage of Kitchen sink linear regression model is that it may indicate a difference between the outcome of interest across the treated and control groups due to the interaction of the treatment variable with other covariates such as gender, location, etc. (Zanutto, 2006). In addition to the treatment effect, Kitchen sink regression model shows the effect of other covariates on the treatment variable. However, the interpretations of the linear regression coefficients are only reliable after a careful fitting of the regression model with appropriate diagnostic checks, including a check of whether there is sufficient overlap in the two groups to facilitate comparisons without dangerous extrapolations.

Disadvantages of the kitchen sink regression model: When the covariate distributions in the two groups (treated and control) are very different, linear regression models (e.g., Kitchen sink regression model) depend on the specific form of the model to extrapolate estimates of treatment differences (Dehejia and Wahba, 1999; Drake 1993; Rubin, 1997). In order words, any misspecification will lead to unbiased and inconsistent estimate of the true impact. The method is based on what Rosenbaum and Rubin (1983) called strong ignorability of treatment or conditional independent assumption (CIA). This means that if we assume that by controlling the variability in the outcome of interest through the inclusion of a set of covariates in the model, the dichotomous treatment variable is independent of the observed outcome across the treated and control groups, then the model is identified. In order words, the ignorability of treatment ensures that the treatment variable is random, that is, the treatment variable is independent of the potential outcomes (Wooldridge, 2002). However, unobserved factors can also cause changes in the outcome of interest. If it is the case and that the factors happen to be related to the treatment variable, the treatment variable is likely to suffer from double endogeneity; one caused by its link to observed characteristics (pure endogeneity) and the other caused by unobserved factors (hidden or omitted variable bias) affecting the outcome of interest.

Kitchen sink regression model is subject to omitted, tainted and mismeasured variables. A tainted variable is a variable that is affected by the treatment variable in the same way the outcome of interest is affected (Zanutto, 2006). Controlling for tainted variable has the effect of concealing the difference in the outcome of interest across treated and control units.

2.6.11.2 Propensity score matching (PSM) model

Obisesan, Omonona, Yusuf and Oni (2012) employed the propensity score matching technique to assess the impact of Root and Tuber Expansion Programme (RTEP) improved production technology on poverty alleviation among cassava-based farming households in Southwest Nigeria. Using a sample of 387 cassava farmers in the study area, the study revealed that the poverty gap among farmers who benefited from the RTEP was lower compared to the non-beneficiaries.

Advantages of the PSM model: Propensity score analysis techniques use observational data to estimate average treatment effect through creation of treated and control groups that have similar covariate values so that subsequent comparisons, made within these matched groups, are not confounded by differences in covariate distributions (Zanutto, 2006). Even though propensity score analysis depends on the specification of the propensity score model, testing the diagnostics for propensity score analysis (checking for balance in the covariates) are much more straightforward than those of regression analysis (residual plots, measures of influence, etc.) and therefore enable the researcher to easily determine the range over which comparisons can be supported Zanutto (2006). Technically, when covariate balance is achieved and no further regression adjustment is necessary, propensity score analysis does not rely on the correct specification of the functional form of the relationship (e.g., linearity or log linearity) between the outcome and the covariates. A non-technical advantage of the propensity score is the intuitive appeal of creating groups of treated and control groups which can be easily understood by a nontechnical audience relatively to Kitchen sink regression model.

Disadvantages of the PSM model: Propensity score analysis depends on the specification of the propensity score model, but the diagnostics for propensity score analysis. Unlike the Kitchen sink regression model, it is designed solely to estimate the overall impact of the treatment variable Zanutto (2006). The method is also based on the strong ignorability of the treatment assumption since it is assume that the matching of the treated and control units has been done based on all the relevant covariates. Similarly to Kitchen sink regression model, propensity score matching is subject to omitted, tainted and mismeasured variables.

It can be concluded that the Kitchen sink regression and the propensity score matching both have a good number of advantages and disadvantages. Therefore the two methods were employed in the current study.

CHAPTER THREE

METHODOLOGY

This chapter presents the methodological approach that was implemented to conduct the study. This involved the presentation of the study area, data collection, sampling technique and the method of data analysis.

3.1 The Study Area

Kaduna State occupies the central portion of Northern Nigeria, about 200 km away from Abuja the Federal Capital. It lies between latitudes 9° and 12°N of the equator and between longitudes 6° and 9°E of the prime meridian. Kaduna State shares boundaries with Katsina and Kano States to the north, Plateau State to the north east, Nasarawa and Abuja to the south, and Niger and Zamfara States to the west (Kaduna State government, 2012).The population of the State according to the 2006 census stands at 6,113,503, using 3.18% growth rate as allowed by the National Population Commission, the projected population of the state in 2013 stands at 7,474,369 (Kaduna State Official Website, 2014). The State has two distinct seasons, the dry season and rainy season. The temperature is hot during the dry season and cool during the rainy season, from November to February the cold dry hamattan wind blows across the State, the Northern part of the state being, affected most. The southern part of the State enjoys heavier rainfall than the Northern part; lasting between 5-6 months in the Southern part and 4-5 months in the Northern part of the state. Generally the rains start in April and end in October.

Kaduna state spans four zones (Birmin Gwari, Lere, Maigana and Samaru) with 23 local government areas as shown in Figure 3.1. Both irrigation and rain-fed farming are practiced in the state. Farming is the main occupation of the people with emphasis on the cultivation of crops such as rice, cassava, ginger, potatoes, millet, groundnut, shea-nut, benni-seed and soya beans aside from animal husbandry. On the irrigated land, vegetable crops like tomatoes, pepper, and cabbage are grown. The cropping systems are dominated by sole and mixed cropping. Some of the farmers are involved in livestock keeping but Fulani herdsmen dominate the rearing of livestock in the area.

The life of the people of the State has been greatly influenced by this geographical setting. The two climatic conditions in the State greatly influence activities of the people, thus the people are predominantly occupied in agriculture during the rainy season which lasts for about six months from May to October, while they engage in hunting and petty trading during the dry season.

According to the National Agricultural Extension Liaison Extension Services (NAERLS, 2013), Kaduna state is the largest producer of cassava in the North West zone of Nigeria. It was found that 276.5 ha and 287.3 ha of land were put under cassava cultivation with estimated output of 1,725, 700 MT and 1,745, 700 MT in 2012 and 2013 respectively (NAERLS, 2013).

Figure 3.1: Study Area (Pink area)

3.2 Sampling Technique

A multistage sampling technique was used to select respondents for this study. The first stage involved a purposive selection of two (2) local government areas based on the predominance of cassava production among the farmers in the study area. Secondly, 3 villages were randomly selected using simple random sampling technique from each local government area. Thirdly, a simple random sampling technique was equally employed to select 10% of the sample frame (1500) of cassava farmers from each of the villages making a sample size of 150 small scale cassava farmers (Table3). Finally, farmers having participated in a given market based their own decision were grouped into two namely participants in processed and fresh cassava market respectively (See Table 3)

Table 3.1: Population and sample size of cassava farmers based on market participation status in the study area

				Market Participation	
Local Government Areas	**Villages**	**Sample frame**	***Sample size**	**PCM (Treatment)**	**FCM (Control)**
Kudan	Jaja	250	25	5	20
	Hunkuyi	200	20	6	14
	Musawa	200	20	2	18
Soba	Yalwa Mai Bene	300	30	1	29
	Anguwan Sako	250	25	1	24
	Pamfo	300	30	8	22
Total		**1500**	**150**	**23**	**127**

**Source: Kaduna State Agricultural Development Project (KADP), Maigana Zone (2014). PCM and FCM = Processed and Fresh Cassava Market Participation respectively.*

3.3 Data Collection

Primary data were exclusively used for this study and were collected with the aid of structured questionnaires. The information was collected on (a) farmer's socio-economic characteristics such as age, household size, educational status, amount of credit received, numbers of extension contact, years spent on the cooperative, and income. (b) Welfare indicators such as access to Information, communication and Technology (ICT), livestock ownership. (c) Information on inputs, output and marketing.

3.4 Method of Data Analysis

This section dealt with the different analytical techniques and empirical specification of the models that were used for the analysis of the different objectives of the study. The analytical tools included gross margin method, stochastic frontier translog production and cost functions, Foster, Greer and Thorbecke poverty decomposition model, logit regression model, Heckman two-step selection model, kitchen sink Tobit regression model and average treatment effect-based propensity score nearest neighbor matching model.

3.4.1 Socioeconomic characteristics of cassava farmers

Descriptive statistics were used to address objective i. Specifically, statistics such as mean, standard deviation, and frequency distribution were used.

3.4.2 Examination of profitability to cassava production

Gross margin model was be used to achieve objective ii. The model is presented as follows:

$$NFI_{ji} = (TR_{ji} - TVC_{ji}) - TFC_{ji} \quad \text{.......} (10)$$

Where

$NFI_{ji} =$ Net farm income (NGN)

$TR_{ji} =$ Total revenue (NGN)

$TVC_{ji} =$ Total variable cost (NGN)

$TFC_{ji} =$ Total fixed cost (NGN)

$j =$ Respondent identifier = $1, 2, \ldots, 150$

$i =$ Type of market participation system = $1, 2$

3.4.3 Examination of economic efficiency levels of cassava farmers

Stochastic frontier Translog production and cost functions were used to address objective iii. The models were specifically used to estimate technical, allocative and economic efficiency levels of the cassava farmers.

3.4.3.1 Estimation of technical efficiency levels of cassava farmers

Stochastic frontier translog production function model was used to estimate the technical efficiency levels of the farmers. The model is presented as follows:

$$lnY_{ij} = \beta_0 + \beta_{1j}lnx_{1ij} + \beta_{2j}lnx_{2ij} + \beta_{3j}lnx_{3ij} + \beta_{4j}lnx_{4ij} + \beta_{5j}lnx_{5ij} + \beta_{6j}lnx_{6ij} + \frac{1}{2}\beta_{7j}(lnx_{1ij})^2 + \frac{1}{2}\beta_{8j}(lnx_{2ij})^2 + \frac{1}{2}\beta_{9j}(lnx_{3ij})^2 + \frac{1}{2}\beta_{10j}(lnx_{4ij})^2 + \frac{1}{2}\beta_{11j}(lnx_{5ij})^2 + \frac{1}{2}\beta_{12j}(lnx_{6ij})^2 + \beta_{13j}(lnx_{1ij}) * (lnx_{2ij}) + \beta_{14j}(lnx_{1ij}) * (lnx_{3ij}) + \beta_{15j}(lnx_{1ij}) * (lnx_{4ij}) + \beta_{16j}(lnx_{1ij}) * (lnx_{5ij}) + \beta_{17j}(lnx_{1ij}) * (lnx_{6ij}) + \beta_{18j}(lnx_{2ij}) * (lnx_{3ij}) + \beta_{19j}(lnx_{2ij}) * (lnx_{4ij}) + \beta_{20j}(lnx_{2ij}) * (lnx_{5ij}) + \beta_{21j}(lnx_{2ij}) * (lnx_{6ij}) + \beta_{22j}(lnx_{3ij}) * (lnx_{4ij}) + \beta_{23j}(lnx_{3ij}) * (lnx_{5ij}) + \beta_{24j}(lnx_{3ij}) * (lnx_{6ij}) + \beta_{25j}(lnx_{4ij}) * (lnx_{5ij}) + \beta_{26j}(lnx_{4ij}) * (lnx_{6ij}) + \beta_{27j}(lnx_{4ij}) * (lnx_{6ij}) + v_{ij} - u_{ij} \qquad (11)$$

Where

Y_{ij} = Cassava output (kg)

x_{1ij} = Land size (ha)

x_{2ij} = Seed (kg)

x_{3ij} = Hired labour (man-day)

x_{4ij} = Family labour (man-day)

x_{5ij} = Fertilizer (kg)

x_{6ij} = Herbicide (Litre)

$(lnx_{1ij})^2$ = Log of land squared

$(lnx_{2ij})^2 =$ Log of seed squared

$(lnx_{3ij})^2 =$ Log of hired labour squared

$(lnx_{4ij})^2 =$ Log of family labour squared

$(lnx_{5ij})^2 =$ Log of fertilizer squared

$(lnx_{6ij})^2 =$ Log of herbicide squared

$(lnx_{mij}) * (lnx_{nij}) =$ Quadratic term of input quantities

$\beta_0 =$ Intercept term

$\beta_1 \ldots \beta_6 =$ First derivatives

$\beta_7 \ldots \beta_{12} =$ Own second derivatives

$\beta_{13} \ldots \beta_{27} =$ Cross second derivatives

$v_{ij} =$ Stochastic error term

$u_{ij} =$ Inefficiency error term

$j =$ Respondent identifier = $1, 2, \ldots, 150$

$i =$ Type of market participation system = $1, 2$

Definition of variables and their a priori expectation: **Cassava output** is the quantity of cassava harvested by both farmers under processed and fresh cassava market participation system during the last farming season in the study area. Fresh cassava roots were packed by farmers in 100 kg bags. However, for the purpose of analysis, 100kg bag was estimated to be about 145 kg using standard conversion factors obtained from IITA (Kambewa, 2010).

Land size: It is the area used for the cultivation of cassava output during the last farming season. It was measured in ha. Based on a priori expectation, increasing land size cultivated by farmers was expected to lead to proportionate increase in total cassava output. In order words, land size was expected to be positively related to cassava output.

Seed: It is the quantity of cassava cuttings (sticks) used for the production of fresh cassava roots (output). The cassava cuttings were packed by farmers in bundles containing on average 40 sticks. A bundle was estimated to weight about 4.5 kg. A priori, increasing the use of cassava cuttings will result to increase in the quantity of cassava output.

Hired labour: It is the quantity of hired labour used in the production of cassava out during the last farming season. It was measured in man-day and was expected to have a positive effect on cassava output.

Family labour: It is the quantity of family labour used in the production of cassava output. It was measured in terms of man-day. The variability in family labour was expected to increase cassava output. That is the sign of the coefficient on family labour was expected to be positive.

Fertilizer: It is the quantity of fertilizer used in the production of cassava output during the last farming season. It was measured in kg. A priori, it was expected to influence cassava output positively. That is the sign of the coefficient on fertilizer was expected to be positive.

Herbicide: It is the quantity of herbicide used in the production of cassava output during the last farming season. Measured in litre, the input was expected to have a positive effect on cassava output. That is the sign of the coefficient on herbicide was expected to be positive.

Quadratic terms: They were introduced to satisfy the specification of the model. The direction of their effects on cassava output is not predictable. That is the quadratic terms in the translog production model were expected to be either positive or negative.

3.4.3.2 Estimation of allocative efficiency levels of cassava farmers

Stochastic frontier translog cost function model was used to estimate the cost efficiency levels of small scale cassava farmers under processed and fresh cassava market participation. The model is presented as follows

$$lnC_{ij} = \alpha_0 + \delta lny_{ij} + \alpha_{1j}lnp_{1ij} + \alpha_{2j}lnp_{2ij} + \alpha_{3j}lnp_{3ij} + \alpha_{4j}lnp_{4ij} + \alpha_{5j}lnp_{5ij} + \alpha_{6j}lnp_{6ij} + \frac{1}{2}\alpha_{7j}\left(lnp_{1ij}\right)^2 + \frac{1}{2}\alpha_{8j}\left(lnp_{2ij}\right)^2 + \frac{1}{2}\alpha_{9j}\left(lnp_{3ij}\right)^2 + \frac{1}{2}\alpha_{10j}\left(lnp_{4ij}\right)^2 + \frac{1}{2}\alpha_{11j}\left(lnp_{5ij}\right)^2 + \frac{1}{2}\alpha_{12j}\left(lnp_{6ij}\right)^2 + \alpha_{13j}\left(lnp_{1ij}\right) * \left(lnp_{2ij}\right) + \alpha_{14j}\left(lnp_{1ij}\right) * \left(lnp_{3ij}\right) + \alpha_{15j}\left(lnp_{1ij}\right) * \left(lnp_{4ij}\right) + \alpha_{16j}\left(lnp_{1ij}\right) * \left(lnp_{5ij}\right) + \alpha_{17j}\left(lnp_{1ij}\right) * \left(lnp_{6ij}\right) + \alpha_{18j}\left(lnp_{2ij}\right) * \left(lnp_{3ij}\right) + \alpha_{19j}\left(lnp_{2ij}\right) * \left(lnp_{4ij}\right) + \alpha_{20j}\left(lnp_{2ij}\right) * \left(lnp_{5ij}\right) + \alpha_{21j}\left(lnp_{2ij}\right) * \left(lnp_{6ij}\right) + \alpha_{22j}\left(lnp_{3ij}\right) * \left(lnp_{4ij}\right) + \alpha_{23j}\left(lnp_{3ij}\right) * \left(lnp_{5ij}\right) + \alpha_{24j}\left(lnp_{3ij}\right) * \left(lnp_{6ij}\right) + \alpha_{25j}\left(lnp_{4ij}\right) * \left(lnp_{5ij}\right) + \alpha_{26j}\left(lnp_{4ij}\right) * \left(lnp_{6ij}\right) + \alpha_{27j}\left(lnp_{5ij}\right) * \left(lnp_{6ij}\right) + v_{ij} + u_{ij} \quad \text{.......... (13)}$$

The allocative efficiency levels of cassava farmers were eventually estimated using the following ratio

$$\hat{A}E_{ij} = \frac{1}{\hat{C}E_{ij}} \quad \text{.......... (14)}$$

Where:

$ln =$ Natural logarithm

$C_{ij} =$ Total cost of cassava production (NGN)

$y_{ij} =$ Cassava output (kg)

p_{1ij} = Cost of land (NGN)

p_{2ij} = Cost of seed (NGN)

p_{3ij} = Cost of fertilizer (NGN)

p_{4ij} = Cost of herbicide (NGN)

p_{5ij} = Cost of hired labour (NGN)

p_{6ij} = Cost of family labour (NGN)

$(lnp_{1ij})^2$ = Log cost of land squared

$(lnp_{2ij})^2$ = Log cost of seed squared

$(lnp_{3ij})^2$ = Log cost of fertilizer squared

$(lnp_{4ij})^2$ = Log cost of herbicide squared

$(lnp_{5ij})^2$ = Log cost of hired labour squared

$(lnp_{5ij})^2$ = Log cost of family labour squared

$(lnp_{ij}) * (lnp_{ij})$ = Quadratic term of input costs

α_0 = Intercept term

δ = Cost elasticity with respect to output

$\alpha_1 \ldots \alpha_6$ = First derivatives

$\alpha_7 \ldots \alpha_{12}$ = Own second derivatives

$\alpha_{13} \ldots \alpha_{27}$ = Cross second derivatives

$\hat{A}E_{ij}$ = Allocative efficiency level

$\hat{C}E_{ij}$ = Cost efficiency level

$\hat{C}E_{ij} \geq 1$

$v_{ij} =$ Stochastic error term

$u_{ij} =$ Inefficiency error term

$j =$ Respondent identifier = $1, 2, \ldots, 150$

$i =$ Type of market participation system = $1, 2$

Definition of variables and their a priori expectation: **Total cost of cassava** output is the total cost of incurred by farmers during the production of cassava output. It was computed as the sum of the cost of the inputs used such as family and hired labour, fertilizer, herbicide, seed and land. It represents the dependent variable in the stochastic frontier translog cost function and was measured in naira.

Cost of land: It represents the amount spent in renting the land used for the production of cassava output and was measured in naira. It is an independent variable in the model and is expected to be positively related to the total cost of production as increase in the cost of land would mean an increase in fixed costs.

Cost of seed: It represents the amount spent in acquiring the cassava cuttings that were used for the production of cassava output. It was expected to influence the total cost of cassava production positively since increasing the cost of seed is expected to increase the variable cost of production.

Cost of hired labour: It is the cost incurred in hiring labour used in the production of cassava during the last farming season and was estimated in naira. A priori, the cost of hired labour is expected to increase the variable cost of production and hence the total cost of production.

Cost of family labour: It is the cost incurred in employing family labour during the production of cassava. The cost was estimated in naira and is expected to be positively related to the variable cost of production and therefore the total cost of production.

Cost of fertilizer: It is the cost incurred in acquiring the quantity of fertilizer (an artificially prepared substance or an organic mature containing nitrogen, phosphorus, or potassium added to soil in order to make plants grow and improve its yields) used in the production of cassava output. Estimated in naira, the cost of fertilizer is expected to be positively correlated with the variable cost of cassava production and hence the total cost.

Cost of herbicide: It is the cost incurred in acquiring the quantity of herbicide (a toxic substance to plants and used to destroy unwanted vegetation, especially weeds) used in the production of cassava output during the last farming season. Estimated in naira, the cost of herbicide is expected to be positively correlated with variable cost and hence the total cost of cassava production.

Quadratic terms: The direction of their effects on cassava output is not predictable. That is the quadratic terms in the translog production model are expected to be either positive or negative.

3.4.3.3 Estimation of economic efficiency levels of cassava farmers

The economic efficiency levels of small cassava farmers under processed and fresh cassava market participation were estimated through the following formula:

$$\hat{E}E_{ij} = \hat{T}E_{ij} * \hat{A}E_{ij} \quad \text{..........} \quad (15)$$

Where

$\hat{E}E_{ij} =$ Economic efficiency level

$\hat{T}E_{ij}$ = Technical efficiency level

$\hat{A}E_{ij}$ = Allocative efficiency level

$0 \leq \hat{E}E_{ij} \leq 1,\ 0 \leq \hat{T}E_{ij} \leq 1$ and $0 \leq \hat{A}E_{ij} \leq 1$

3.4.4 Examination of the poverty profile of cassava farmers

Foster-Greer-Thorbecke (FGT) poverty decomposition model was used to address objective iv. The model is expressed as follows:

$$P_\alpha = \frac{1}{n}\sum_{j=1}^{q}\left[\left(\frac{g}{z}\right)^{\alpha} I(y_{ji} < Z)\right] \quad \text{.. (16)}$$

Where

$P_\alpha =$ Poverty parameter

$\alpha =$ The degree of poverty aversion

$n =$ Total number of cassava farmers

$q =$ Number of poor farm households

$g = z - y_i =$ Per capita income shortfall (NGN)

$y_i =$ Annual per capita income (NGN)

$Z =$ Poverty line

$I(y_i < Z) =$ Indicator function such that

$$I(y_i < Z) = \begin{cases} 1\ if\ y_i < Z \\ 0\ if\ y_i > Z \end{cases}$$

$\alpha = 0,\ P_\alpha = P_0$ = Poverty incidence (Headcount)

$\alpha = 1,\ P_\alpha = P_1$ = Poverty gap (depth)

$\alpha = 2,\ P_\alpha = P_2$ = Poverty severity (Squared poverty gap)

$j =$ Farm household identifier = $1, 2, \ldots, 150$

$i =$ Type of market participation system = $1, 2$

3.4.5 Determination of the factors affecting the poverty status of cassava farmers

Logit regression model was used to address objective v. The model is specified as follows:

$$L_{ij} = ln\left(\frac{p_i j(y=1)}{1 - p_i j(y=1)}\right) = \alpha_0 + \alpha_1 x_{1ij} + \alpha_2 x_{2ij} + \alpha_3 x_{3ij} + \alpha_4 x_{4ij} + \alpha_5 x_{5ij}$$

$$+\alpha_6 x_{6ij} + \alpha_7 x_{7ij} + \alpha_8 x_{8ij} + \alpha_9 x_{9ij} + \alpha_{10} x_{10ij} + \alpha_{11} x_{11ij} + \alpha_{12} x_{12ij}$$

$$+\alpha_{13} x_{13ij} + \alpha_{14} x_{14ij} + u_j \quad \text{...} (17)$$

Where

$L_{ij} =$ Logit of becoming non-poor

$p_i j(y = 1) =$ Probability of becoming non-poor

$y =$ Poverty status

$x_{1ij} =$ Age (years)

$x_{2ij} =$ Level of education

$x_{3i} =$ Land size (ha)

$x_{4ij} =$ Improved cassava cuttings

$x_{5ij} =$ Cropping system

$x_{6ij} =$ Cassava output (kg)

$x_{7ij} =$ ICT use

$x_{8ij} =$ Access to credit

$x_{9ij} =$ Association membership

$x_{10ij} =$ Extension service

$x_{11i} =$ Livestock ownership

$x_{12i} =$ Farm gate

$x_{13i} =$ Distance to market (km)

$x_{14i} =$ Location status

$\alpha_0 =$ Intercept term

$\alpha_1 \ldots \alpha_{14} =$ Partial regression (Slope) coefficients

$u_j =$ Stochastic error term

$j =$ Farm household identifier = $1, 2, \ldots, 150$

$i =$ Type of market participation system = $1, 2$

3.4.5.1 Definition of the variables and their a priori expectation

Poverty status: The dependent variable poverty status is a dichotomous response variable taking 1 if a farm household is nonpoor and 0 if poor. The categorization of farm household into nonpoor and poor was based on the definition of a poverty line. The poverty line was estimated using the new international poverty line of $1.25 USA which was in the local currency converted using the Purchasing Power Parity (PPP) index. The line was finally estimated to be about NGN 60, 393.6. Thus, a farm household with equal or more than NGN 60, 393.6 was considered nonpoor while those with less than NGN 60, 393.6 were considered poor.

Age: It is the age of the member who makes key decisions in the household and whose authority is acknowledged by other members. This refers to age at last birth. For instance if a household head would be 25 years old in two weeks after the interview, the age recorded would be 24. Gani and Adeoti (2011), Oladimeji, Abdulsalam, Damisa and Omokore (2014) found that experience increases with age which in turn could enable farmers to organize their farm in an efficient way in order to boast yield and hence reduce poverty through improvement in income. According to Mukundi, Mathenge and Ngigi (2013), age can be used as measure of risk attitude of the farmer. Young farmers are expected to be more favorable in taking the risk of adopting improved technology while older ones are often conservative. This could cause younger farmers to be more able to reduce poverty than the older ones. The direction of influence of age is therefore ambiguous.

Level of education: It is the highest level of education completed by the household head. For instance, if a household head dropped out at Jss3, his/her highest level of education is Jss2 which is equivalent to 8 years of education based on the reasoning that a farmer who completed either primary, junior secondary, senior secondary, under graduate, master or PhD education is estimated to have spent either 6, 9, 11, 14, 16 or 19 years of education. Education exposes individuals to better and alternative means of livelihood and as such is expected to be positively related to poverty (Olawuyi and Adetunji, 2013).

Land size: It is the area used for the cultivation of cassava output. It was measured in ha. It is a regressor and was used in the model as a dummy variable taking 1 if a household had more than or equal to 1 ha of land and 0 otherwise. If resources are well used, poverty is expected to decrease with increase in farm size which could be translated into increased output and more income, all things being equal (Olawuyi and Adetunji, 2013; Ezeh, Anyiro, Ogbonnaya, and Obioma 2013). Land size was thus hypothesized to be positively related to poverty status.

Improved cassava cuttings: It refers to the type of variety of cassava cuttings for the production of cassava output. It is a regressor and was employed in the model in the form of dummy variable taking 1 if a famer used an improved variety of cassava cuttings and 0 otherwise. The adoption of high yielding variety (HYV) is observed in the literature to having the ability to influence the poor directly by improving income through enhancement in productivity and indirectly through employment of landless laborers and reduction in output prices (Dontsop, Diagne, Okoruwa, Okoruwa and Ojehomon, 2011; Awotide, Diagne and Omonona, 2012). Improved cassava cuttings were thus expected to be positively related to poverty status.

Cropping system: It refers to the pattern of crop planting adopted by farmers. 4 categories of cropping systems were considered namely mono-cropping, mixed-cropping, intercropping, and other cropping systems such as alley-cropping, relay cropping and strip cropping. The four categories were recoded into a dummy variable where 1 referred to mixed-cropping system and 0 otherwise. According to Bamidele, Babatunde and Rasheed (2008), cassava, when cultivated as a sole crop, results in high outputs. However, the greatest disadvantage of sole cropping is that in instances of pest or disease outbreaks that attacks the soled crops, farmers usually loose a significant part of their crops and sometimes even all (Fakayode *et al.*, 2008). Thus, mixed cropping system is hypothesize to have a positive relationship with poverty status as most farmers opine that mixed cropping system is the best agronomic practice that maximizes their output per hectare (Bamidele *et al.* 2008, Fakayode *et al.*, 2008).

Cassava output: It is the quantity of cassava harvested by both farmers under processed and fresh cassava market participation systems. Fresh cassava roots were packed by farmers in 100kg bags. However, for the purpose of analysis, 100kg bag of cassava was estimated to be about 145kg using standard conversion factors obtained from IITA (Kambewa, 2010). Otsuka (2000) and Binswanger and Quizon (1989) found out that output expansion and the resulting decline in food prices was the primary mechanism through which the green revolution decreased inequality and poverty (Irz *et al.* 2001). A priori, cassava output is hypothesized to be positively related to poverty status.

ICT use: It is a dummy variable taking 1 if the household head used any device such a radio, television set, telephone, etc... to acquire agricultural related information. ICT could be used for improving information dissemination to farmers by extension agent. It is expected to be positively correlated with poverty status.

Access to credit: It refers to a situation whereby a farmer used part or all the credit received from sources such as bank, cooperative societies, money lender, friends, family or other sources to invest in cassava production. It is a dummy variable taking 1 if a farmer used part or all the credit received from one or more of the aforementioned sources to invest in cassava production and 0 otherwise. Credit assists farm households in the purchase of farm inputs such as fertilizer, herbicides, improved seeds and investment demand which will ultimately increase their productivity. Therefore, a unit increase in the amount of credit received by farm households will increase the probability of the households becoming non-poor (Adekoya, 2014). Thus, access to credit is expected to be positively related to poverty status.

Association membership: It is the number of years a cassava farmer or farm household has spent as a member of any farmers' association. It is expected to be inversely related to poverty as there is possibility to take advantage of social networks to acquire more knowledge about farming activities. According to Verhofstadt and Maertens (2014), farmers' cooperative association is effective in improving rural incomes and reducing rural poverty. Thus, contact with farmers' association is hypothesized to be positively related to poverty status.

Extension service: It refers to the number of years a farm household collaborated with extension agents. According to Christoplos (2010), extension and rural advisory services (RAS) are crucial to putting farmers' needs at the centre of rural development, ensuring sustainable food security and poverty reduction, and dealing with risks and uncertainty. It is expected to be positively related to poverty status as cassava farmer or farm household has the opportunity to receive technical assistance or advice (demonstration of new agricultural techniques) in order to improved productivity and therefore income.

Farm gate: Three types of locations were farmers sell their produce were considered namely farm gate, village market and any market outside village environment. Market's type was used as a dummy variable taking 1 if a farmer sold his/her produce at the farm gate and 0 otherwise. Empirical evidence suggests that cost of transportation reduces income for over 15% (Karfakis, Velazco, Moreno and Covarrubias, 2011). Thus, market's type is expected to be positively related to poverty as selling at the farm gate has the advantage of reducing transaction (transportation) cost and therefore increasing income.

Distance to market: It refers to the distance from the farm where cassava output was cultivated/ harvested to the market where it was sold. It was measured in km. it is expected to be positively related to poverty as good roads or smaller distance to market reduces expenditure on foods and inputs.

Location status: It refers to the Local Government Area (LGA) where a cassava farmer is from. It is a dummy variable taking 1 if a farmer is from Soba LGA and 0 if he/she is from Kudan LGA. It was introduced in the model in order to capture geographical cost of living differences which could be natural or human-induced (local public services). Thus, the direction of its effect on poverty is ambiguous.

3.4.6 Determination of the factors affecting the decision and level of processed cassava market participation

Heckman Two-step Selection Model was used to achieve objective vi. The model is a two-part model but was estimated simultaneously using the Stata command *heckman.* The first part examines the factors affecting the decision to participate in processed cassava market system while the second part examines the factors affecting the level of participation in processed cassava market system.

3.4.6.1 Factors affecting processed cassava market participation decision

The first part (equation) of the Heckman two-step model was estimated using a probit model. The model is presented as follows:

$$p_{ij}(w_{ij}|X_{ij}) = \alpha_0 + \alpha_1 x_{1ij} + \alpha_2 x_{2ij} + \alpha_3 x_{3ij} + \alpha_4 x_{4ij} + \alpha_5 x_{5ij} + \alpha_6 x_{6ij} + \alpha_7 x_{7ij} + \alpha_8 x_{8ij} + \alpha_9 x_{9ij} + \alpha_{10} x_{10ij} + \alpha_{11} x_{11ij} + \alpha_{12} x_{12ij} + \alpha_{13} x_{13ij} + \alpha_{14} x_{14ij} + u_{ji} \quad (18)$$

Where:

$p_{ij} = E(w_{ij}|X_{ij})$ = Conditional probability

$w_{ij} =$ Market participation status

$x_{1ij} =$ Age (years)

$x_{2ij} =$ Marital status

$x_{3ij} =$ Level of education

$x_{4i} =$ Land size (ha)

$x_{5ij} =$ Quantity of cassava cuttings (kg)

$x_{6ij} =$ Quantity of fertilizer (kg)

$x_{7ij} =$ Improved cassava cuttings

$x_{8ij} =$ Cropping system

$x_{9ij} =$ Extension service

$x_{10ij} =$ Access to credit

$x_{11i} =$ Location status

$x_{12ij} =$ Cassava output (kg)

$x_{13ij} =$ Price of output (NGN)

$\alpha_0 =$ Intercept/constant term

$\alpha_1 \dots \alpha_{14} =$ Partial regression (Slope) coefficients

$u_{ji} =$ Stochastic error term

$j =$ Farm household identifier = $1, 2, \dots, 150$

$i =$ Type of market participation system = $1, 2$

3.4.6.2 Definition of the variables and their a priori expectation

Market participation status: It is a dichotomous response variable taking 1 if a farmer sold processed cassava output and 0 otherwise.

Age: Measured in years, it refers to the age of the household head who makes key decisions in the household and whose authority is acknowledged by other members. According to Mukundi, Mathenge and Ngigi (2013), age of the household head can be used as measure of risk attitude of the farmer. Increase in age of household head is expected to have negative effect market participation due to risk-averse nature of older farmers. Age may influence market participation through various channels such as experience, access to resources and risk preferences. The expected direction of the effect of age is thus ambiguous (Zamasiya, Mango, Nyikahadzoi and Siziba, 2014).

Marital status: It refers to the household head's marital status on the day of interview. 6 types of marital statuses were considered: married, informal union, divorced, widowed and never married. Marital status was coded into a dummy variable where 1 referred to married and 0 otherwise. Marital status has being found to influence social organization and economic activities such as agriculture and resource management within a household

(Nyunza and Mwakaje, 2012). We thus, expect marital status to have a positive effect on market participate decision.

Level of education: It is the highest level of education completed by the household head. For instance, if a household head dropped out at Jss3, his/her highest level of education is Jss2. Thus, a farmer that completed either primary, junior secondary, senior secondary, under graduate, master or PhD education was estimated to have spent either 6, 9, 11, 14, 16 or 19 years of education. Education level of the household is used as a proxy for human capital endowment. Education enhances the ability of farmers to utilize market information which could lower transaction cost thereby making market participation worthwhile (Olwande and Mathenge, 2010). Thus, level of education is expected to be positively related to the probability to participate in processed cassava market.

Land size: It is the area used for the cultivation of cassava output. It was measured in ha. It is a regressor and was used in the model as a dummy variable taking 1 if a household had more or equal to 1 ha of land and 0 otherwise. Ogunbameru and Okeowo (2013) found that land size has a positive impact on cassava output. Olwande and Mathenge (2010) argue that land may have indirect positive effect on market participation such as collateral for credit that would enhance adoption of improved technologies which in turn would increase agricultural productivity and crop output market participation. We thus, land size is expected to be positively related to the probability to participate in processed cassava market.

Quantity of cassava cuttings: It is used for the production of fresh cassava roots (output). The cassava cuttings were packed by farmers in bundles containing on average 40 sticks. A bundle was estimated to weight about 4.5kg. Iheke (2008) estimated that cassava cuttings are positively and significantly related to cassava output which in turn will increase the probability to participate in processed cassava market. A priori, quantity of seed is expected to be positively associated with the decision to participate in processed cassava market.

Quantity of fertilizer: It is the quantity of fertilizer used in the production of cassava output during the last farming season. It was measured in kg. Ojeniyi, Adejoro, Ikotun and Amusan (2012) in their study in south western Nigeria, found that the application of poultry manure and/or NPK fertilizer increases cassava growth and had recommended it for high performance as sustainable cultivation of the crop. Okezie and Okoye (2006) and Oladeebo and Oyetunde (2013) observed that output is dependent on amount of soil fertility in crop production. In other words, soil fertility is powered by the quantity of fertilizer applied to the soil. A priori, quantity of fertilizer is thus expected to influence cassava output and therefore market participation positively.

Improved cassava cuttings: It refers to the variety of cassava cuttings used for the production of cassava output. It was employed in the model in the form of dummy variable taking 1 if a famer used an improved variety of cassava cuttings and 0 otherwise. Improved seed varieties have high yield potential and are disease and pest resistant thus improve productivity and marketable surplus (Technoserve, 2011). Cassava variety is, thus, expected to be positively associated with the probability to participate in processed cassava market.

Cropping system: It refers to the pattern of crop planting adopted by farmers. 4 categories of cropping systems were considered namely mono-cropping, mixed-cropping, intercropping, and other cropping systems. The four categories were recoded into a dummy variable where 1 referred to mixed-cropping and intercropping systems and 0 otherwise. The coding is justified by the fact that many works confirmed that cassava is usually intercropped with legumes or grain crops (Natarajan and Willey, 1980; Hulugalle and Ezumah, 1991; Fakayode *et al.*, 2008; Oguoma and Nwosu, 2009). The monetary returns per ha are appreciably higher under intercropping systems, and is mainly due to the higher value of intercrops (Prabhakar *et al.*, 1996). Cropping system was thus hypothesized to have positive effect on market participation since the overall profit acquired as a result of efficient utilization of land could serve as additional capital to purchase improved inputs which will lead to increased productivity and market participation.

Access to credit: It refers to a situation whereby a farmer used part or all the credit received from sources such as bank, cooperative societies, money lender, friends, family or other sources to invest in cassava production. It is a dummy variable taking 1 if a farmer used part or all the credit received from the aforementioned sources to invest in cassava production and 0 otherwise. Credits are expected to enhance farmer skills and knowledge, link farmers with modern technology through the purchase of inputs (planting materials, fertilizer and crop protection), pay wages, invest in machinery, or to smooth consumption as well as markets, ease liquidity and input supply constraints, and thus, leading to increase agricultural productivity, induce market orientation and participation and thus greater commercialization (Lerman, 2004; Martey *et al*, 2012).

Location status: It refers to the Local Government Area (LGA) where a cassava farmer is from. It is a dummy variable taking 1 if a farmer is from Soba LGA and 0 if he/she is from Kudan LGA. Community status was used in the model to account for any socio-economic and agro-potential differences that may arise within the households across the LGAs of the study area.

Cassava output: It is the quantity of cassava harvested by both farmers under processed and fresh cassava market participation system during the last farming season in the study area. Fresh cassava roots were packed by farmers in 100 kg bags. However, for the purpose of analysis, 100kg bag was estimated to be about 145 kg using standard conversion factors obtained from IITA (Kambewa, 2010).

Price of output: It refers to the amount received by farmers for the sale of a kg of cassava output. According to the law of demand and supply, increased in the market price of processed cassava market will increase both the probability and the intensity of participation in the processed market. Most economists argue that relative prices form critical incentives to induce market participation and increase the amount of marketable surplus (Fafchamps and Hill, 2005; Alene *et al.*, 2008).

3.4.6.3 Factors affecting processed cassava market participation level

The second part of the model is specified as follows:

$$ln(I_{ij}|Z_{ij}) = \beta_0 + \beta_1 z_{1ij} + \beta_2 z_{2ij} + \beta_3 z_{3ij} + \beta_4 z_{4ij} + \beta_5 z_{5ij} + \beta_6 z_{6ij} + \beta_7 z_{7ij} + \beta_8 z_{8ij} \rho\lambda(\alpha) + v_i \quad (19)$$

Where

I_{ij} = Level of market participation

Z_{ij} = Matrix of the independent variables

β_0 = Intercept term

z_{1ij} = Age (years)

z_{2ij} = Marital status

z_{3ij} = Level of education (years)

z_{5i} = Land size (ha)

z_{6ij} = Quantity of seed (kg)

$z_{7ij} =$ Contact with extension agents (years)

$z_{8ij} =$ Price of processed cassava output (NGN)

$\lambda(\alpha)_{ij} =$ Inverse of Mills Ratio

$\rho = cov(u_j, v_j)$

$j =$ Farm household identifier $= 1, 2, \ldots, 150$

$i =$ Type of market participation system $= 1, 2$

3.4.6.4 Definition of variables and their a priori expectation

Level of market participation: It is the dependent variable and represents the quantity of processed cassava sold.

Age: It is the age of the member who makes key decisions in the household and whose authority is acknowledged by other members. This refers to age of the household head at last birth. For instance if someone would be 25 years old in two weeks after the interview, the age recorded would be 24. Following Chirwa and Matita (2012) who opined that, older household heads are more likely to have large household sizes, increasing the food need requirements of households which in turn will reduce their degree of market participation, age of household head was hypothesized to be negatively related to the level of participation in processed cassava market.

Marital status: It refers to the household head's marital status on the day of interview. Six types of marital statuses were considered: married, informal union, divorced, separated, widowed and never married. However, for the purposed of analysis, the categorical variable was recoded into a dummy variable where 1 referred to married and 0 otherwise. Smallholder rural farmers who are married tend to engage their family members in agricultural production. Since most households rely on family labour, households with more labour are more likely to commercialize (Jaleta *et al.*, 2009). However, the contribution of family labour to productivity depends on the quality of the family labour. Thus, marital status of household head was hypothesized to have ambiguous effect on the level of market participation.

Level of education: It is the highest level of education completed by the household head. For instance, if a household head dropped out at Jss3, his/her highest level of education is Jss2. Thus, a farmer that completed either primary, junior secondary, senior secondary, under graduate, master or PhD education was estimated to have spent either 6, 9, 11, 14, 16 or 19 years of education. Education increases the ability of farmers to gather and analyze relevant market information which would improve the managerial ability of the farmers in terms of better formulation and execution of farm plans, and acquiring better information to improve their marketing performance (Tufa, Bekele and Zemedu, 2014). Level of education was equally hypothesized to influence the quantity of processed cassava sold.

Land size: It is the area used for the cultivation of cassava output. It was measured in hectare and was used in the model as a dummy variable taking 1 if a household had more or equal to 1 ha of land and 0 otherwise. Land is a critical production asset having a direct bearing on production of surplus due to economies of scale (Tufa, Bekele and Zemedu, 2014). According to (Onubuogu, Esiobu, Nwosu and Okereke, 2014), large farm size increases agricultural productivity and improves farmers' technical, allocative and resource use efficiency. Land size was thus, expected to have positive effect on the level of market participation.

Quantity of cassava cuttings: It is the quantity of cassava cuttings (sticks) used for the production of fresh cassava roots (output). A priori, increasing the use of cassava cuttings will result to increase in the quantity of cassava output. The quantity of cassava cuttings is a significant input in cassava production. Cassava output has been found to be elastic to cassava cuttings (Nandi, Gunn and Yurkushi, 2011; Onubuogu, Esiobu, Nwosu and Okereke, 2014). Quantity of seed was thus expected to have positive effect on the level of market participation.

Association membership: It is the number of years a cassava farmer or farm household has spent as a member of any farmers' association. Being a member of farmers' association has the advantage of strengthening farmers' bargaining and lobbying power and also serves as source of information to the farmers, increasing their propensity to participate in the market (Adenegan, Adepoju and Nwauwa, 2012). Contact with farmers' association was thus expected to influence the level of participation in processed cassava market.

Price of output: It refers to the amount received by farmers for the sale of a kg of cassava output. Theoretically, an increase in output will induce an increase in the quantity supplied. Thus, price of processed cassava was expected to influence positively the quantity of cassava sold.

3.4.7 Estimation of the impact of processed cassava market participation on economic efficiency level

Kitchen Sink Tobit regression model was used to address objective vii. However, the propensity scores of processed cassava market participation needs first to be estimated.

3.4.7.1 Estimation of propensity scores

The propensity scores of processed cassava market participation were estimated based on the following logit model:

$$L_{ij} = \alpha_0 + \alpha_1 x_{1ij} + \alpha_2 x_{2ij} + \alpha_3 x_{3ij} + \alpha_4 x_{4ij} + \alpha_5 x_{5ij} + \alpha_6 x_{6ij} + u_{ij} \quad \text{(20)}$$

$L_{ij} =$ Logit of participating in processed cassava market

$x_{1ij} =$ Age (years)

$x_{2ij} =$ Marital status

$x_{3ij} =$ Cropping system

$x_{4ij} =$ Improved cassava cutting

$x_{5i} =$ Land size (ha)

$x_{6i} =$ Farm gate

$u_j =$ Stochastic error term

$j =$ Farm household identifier = $1, 2, \ldots, 150$

$i =$ Type of market participation system = $1, 2$

3.4.7.2 Impact of processed cassava market participation on economic efficiency level

Kitchen sink Tobit regression model is specified as follows:

$$EE_{ij} = \alpha_0 + \varphi w_{ij} + \alpha_1 \widehat{p}_{ij\left(w_{ij}=1 \middle| X_{ij}\right)} + \alpha_2 w_i\left(\hat{p}_{ij} - \overline{\hat{p}_i}\right) + u_i \quad \text{(21)}$$

Where

$EE_{ij} =$ Economic efficiency

$\alpha_0 =$ Intercept term

$\varphi = ATE$ (Impact) of participation in processed cassava market

$\overline{\hat{p}_i}$= Average propensity score

$\hat{p}_{ij}(x) =$ Propensity score

$0 \leq EE_{ij} \leq 1$

$j =$ Farm household identifier = $1, 2, \ldots, 150$

$i =$ Type of market participation system = $1, 2$

3.4.8 Estimation of the impact of participation in processed cassava market system on poverty level

Propensity score matching-based nearest neighbor matching. Like in the previous section, the propensity scores of the processed cassava market participation were first estimated in order to identify the statistical control group.

3.4.8.1 Estimation of propensity scores

The propensity scores were estimated based on the following logit model

$$L_{ij} = ln\left(\frac{p_i j}{1 - p_{ij}}\right) = \alpha_0 + \alpha_1 x_{1ij} + \alpha_2 x_{2ij} + \alpha_3 x_{3ij} + \alpha_4 x_{4ij}$$

$$+\alpha_5 x_{5ij} + \alpha_6 x_{6ij} + u_{ij} \quad \text{.......} \quad (22)$$

Where:

$L_{ij} =$ Logit of participating in processed cassava market

$x_{1ij} =$ Age (years)

$x_{2ij} =$ Marital status

$x_{3ij} =$ Cropping system

$x_{4ij} =$ Improved cassava cuttings

$x_{5ij} =$ Land size (ha)

$x_{6jij} =$ Farm gate

$u_{ij} =$ Stochastic error term

$j =$ Farm household identifier = $1, 2, \ldots, 150$

$i =$ Type of market participation system = $1, 2$

3.4.8.2 Impact of processed cassava market participation on poverty level

Propensity score matching-based nearest neighbor matching is specified as follows:

$$A\hat{T}E_1 = \frac{1}{n_T}\left[\sum_{i\in T} y_{1ij} - \sum_{i\in u} \omega(i,j) y_{0ij}\right] \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.\dots\dots..(23)$$

Where

$A\hat{T}E_1$ = Impact of participation in processed cassava market

$n_T =$ Number of farmers within the i^{th} cassava market

y_{1ji} = Per capita income of the treated farmers (NGN)

y_{0ji} = Per capita income of the untreated farmers (NGN)

$\omega(i,j) =$ Weight

The user written command ***attnd.ado*** in Stata 12 statistical program was used to estimate both the propensity score and equation (22)

$j =$ Farm household identifier = $1, 2, \dots, 150$

$i =$ Type of market participation system = $1, 2$

3.4.9 Test-statistics for the hypotheses

3.4.9.1 T-test

The t-statistic used to test hypothesis i of the study was based on the assumption that the variance of profitability proxy by net farm income was equal across farmers under the PCMS and FCMS. Under the null hypothesis, the test statistic is given as:

$$t = \frac{(\bar{x}_{PCMS} - \bar{x}_{FCMS})}{\sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)\left(\frac{(n_1-1){s_1}^2 + (n_2-1){s_2}^2}{n_1+n_2-2}\right)}}$$

Where

$t =$ Test-statistic

$\bar{x}_{PCMS} =$ Average net farm income among farmers under PCM

$\bar{x}_{FCMS} =$ Average net farm income among farmers under FCM

${s_1}^2 =$ Variance of the net farm income among farmers under PCM

${s_2}^2 =$ Variance of the net farm income among farmers under FCM

$n_1 =$ Number of farmers under PCM

$n_2 =$ Number of farmers under FCM

The T-statistic used to test hypothesis iv and v can be given as

$$T = \frac{ATE}{\sigma_{ATE}}$$

$ATE =$ Average Treatment Effect

$\sigma_{ATE} =$ Standard error of ATE

3.4.9.2 F-statistic

The F-statistic used to test hypothesis ii can be presented as follows:

$$F = \frac{MS_{between}}{MS_{within}}$$

$MS_{between} =$ Mean square between groups = $\frac{\sum_{i=1}^{k} n_i(\overline{EE}_i - \overline{\overline{EE}})^2}{k-1}$

$MS_{within} =$ Mean square within groups = $\frac{SS_{within}}{df_{within}}$

$SS_{within} =$ Sum of square within groups = $\sum_{j=}^{n_i}(EE_{ij} - \overline{EE}_i)^2$

$df_{within} =$ Degree of freedom within groups = $n_i - 1$

$k =$ Number of categories of the treatment variable

$n_i =$ Number of small scale farmers within the i^{th} category

$\overline{EE}_i =$ Mean economic efficiency level within the i^{th} category

$EE_{ij} =$ Economic efficiency level of the j^{th} farmer within the i^{th} category

$\overline{\overline{EE}} =$ Grand or total mean of the economic efficiency level of the whole sample of small scale farmers.

In testing hypothesis iii, the following represents the components of the F-statistic.

$MS_{between}$ = Mean square between groups = $\frac{\sum_{i=1}^{k} n_i(\bar{P}_{i\alpha}-\bar{\bar{P}}_{\alpha})^2}{k-1}$

MS_{within} = Mean square within groups = $\frac{SS_{within}}{df_{within}}$

SS_{within} = Sum of square within groups = $\sum_{j=}^{n_i}(P_{ij\alpha} - \bar{P}_{i\alpha})^2$

df_{within} = Degree of freedom within groups = $n_i - 1$

k = Number of categories of the treatment variable (processed and fresh cassava market participation systems)

n_i = Number of small scale farmers within the i^{th} category

$\bar{P}_{i\alpha} = \frac{1}{n}\sum_{j=1}^{q}\left[\left(\frac{g_{ij}}{Z}\right)^{\alpha} I(y_{ij} < Z)\right]$ = Average poverty profile level within the i^{th} category

$P_{ij\alpha} = \left(\frac{g_{ij}}{Z}\right)^{\alpha} I(y_{ij} < Z)$ = Poverty profile level for the j^{th} farmer within the i^{th} cassava market participation system

$\bar{\bar{P}}_{\alpha}$ = Grand or total average poverty profile level for the whole sample of small scale farmers

n = Total number of observations

j = 1, 2...150

i = 1, 2

$g_{ij1} = z - y_{ij1}$ = Annual per capita income shortfall

y_{i1} = Annual per capita income

Z = Annual poverty line = NGN [(U.S $1.25)**PPPD**365]

α = The degree of poverty aversion

If $\alpha = 0$, $\overline{P_{\alpha}} = \overline{P_0}$ = Average Poverty incidence (Headcount)

$\alpha = 1$, $\overline{P_\alpha} = \overline{P_1}$ = Average Poverty gap

$\alpha = 2$, $\overline{P_\alpha} = \overline{P_2}$ = Average Poverty severity (Squared poverty gap)

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Cassava Farmers

This study was based on survey data collected on small scale cassava farmers, between August and September 2014 from two Local Government Areas (LGAs) of Kaduna State namely Soba and Kudan. The data were related to their 2013 farming season. Some selected features of the sampled cassava farmers were described via the use of descriptive statistics and frequency distribution in order to have preliminary information on their individual and farm-specific characteristics.

4.1.1 Market participation status

The results of the analysis in Table 4.1 reveal that out of 150 cassava farmers considered for the study only 27 (18%) were identified as participants in processed cassava market (PCM) while the remaining 123 farmers (82%) participated in fresh cassava market system (FCM) (Figure 3). The implication of this description is that the level of participation in PCM is quite low in the study area. Processing facilities are usually expensive and lack of it could result in farmers opting for the sale of fresh cassava rather than the processed one. According to Ani, Agbugba and Baiyegunhi (2013), the low level of participation in processed cassava market could be explained by the fact that cassava processing and marketing is regarded as a boring and hard work by farmers in the study area, thereby limiting the ability of the farmers to improve their potentials in processing techniques and activities; reduce their level of participation and marketing of the product and consequently retard the expansion and investment in the processing business.

Table 4.1: Distribution of farmers based on cassava market participation status in Maigana Zone, Kaduna State

Market participation status	Frequency	Percentage
Processed cassava sellers	27	18
Fresh cassava sellers	123	82
Total	**150**	**100**

4.1.2 Sex

The result in Table 4.2 shows that even though female were not as involved in the production and marketing of fresh and processed cassava as male, cassava production and marketing is still not gender exclusive in the study area. The result contradicts the findings of most previous studies on cassava production and processing such as those of Adebayo (2013) and Igberi and Awoke (2013) who observed that cassava production and processing are more dominated by female than male. The PIND (2011) opined that women play a central role in cassava production, processing and marketing, contributing about 58% of the total agricultural labour in the southwest, 67% in the southeast and 58% in the central zones. However, the finding corroborates the study of Amos (2013) who observed that males constituted the majority of cassava farmers in Wamba LGA of Nassarawa state with 86.50% of total respondents. According to Amos (2013), the implication of the low involvement of female farmers in the production and sale of the processed, could be as a result high labour requirements and land ownership pattern which favour the males.

Based on market participation, the proportion of male farmers who participated in PCM (18.12%) was significantly less than those involved in the FCM (81.88%) at 1% level of probability. This finding is consistent with the results of Zamasiya *et al.* (2014) who observed that male farmers among the market participating households are significantly less than those in the non-market participating households.

Table 4.2: Distribution of the cassava farmers based on sex and across market participation systems in Maigana Zone, Kaduna State

	Market participation			
Gender	**PCM**	**FCM**	**Total**	**Z-test**
Male	27 (18.12)	122 (81.88)	149 (100)	-20.33***
Female	0 (0)	1 (100)	1 (100)	***NA***
Total	**27(18)**	**123(82)**	**150**	

**** P<0.01. Values in brackets are percentages*

4.1.3 Age of household head

The result in Table 4.3 indicates that, on average, cassava farmers in the study area were 37 years old with low variation around the mean age which is reflected in the small standard deviation of age (0.75). This is an advantage for the adoption and spread of innovative practices since young people are likely to accept and serve better as agent of innovation transfer (Onu and Madueke, 2002). Moreover, youths are said to be less risk averse and may have better exposure to new ideas. The results is consistent with the findings of Oluwasola (2010) who observed that 74% of cassava farmers in Oyo state were less or equal to 39 years old.

Although, the mean age of farmers who participated in the PCM was 38 years with a standard deviation of 1.79 while that of the farmers who participated in the FCM was 37 with a standard deviation of 0.83, no statistical significant difference was observed suggesting that farmers who participated in the PCM and FCM respectively will have the equivalent attitude towards adoption of improved technology and transfer of innovation and management of marketing information.

Table 4.3: Distribution of respondents based on age classes and across market participation in Maigana Zone, Kaduna State

Age of Household head	**Market participation**			
	PCM (27)	**FCM (123)**	**Total (150)**	**Z-test**
<=30	7(18.42)	31(81.58)	38(100)	-10.27***
31-40	10(13.51)	64(86.49)	74(100)	-17.85***
41-50	8(27.59)	21(27.59)	29(100)	-5.28***
>50	2(22.22)	7(77.78)	9(100)	4.06***
Mean	**38 (1.79)**	**37 (0.83)**	**37 (0.75)**	**0.77**

**** P<0.01. Values in brackets are percentages*

4.1.4 Household size

The result in Table 4.4 shows that, irrespective of market participation status, cassava farmers in the study area had an average household size of 11 with a standard deviation of 0.49. Across market participation status, farm households who participated in the PCM had, on average, a household size of 13 while those who participate in the FCM had a household size of 10. The observed difference between the two groups of farmers was significant at 5% level of probability. The implication of the finding is that cassava farmers who participate in PCM will have more support in production and marketing of their produce in terms of family labour than their counterparts even though the distribution of the respondents across the household size classes shows that the proportion of farmers who participated in the FCM was significantly greater than their counterparts across the defined household size classes.

Table 4.4: Distribution of respondents based on household size classes and across market participation in Maigana Zone, Kaduna State

	Market participation			
Family Size	**PCM (27)**	**FCM (123)**	**Total (150)**	**Z-test**
<=5	1(4.35)	22(95.65)	23(100)	-12.73***
6-10	6(9.84)	55(90.16)	61(100)	-20.83***
11-15	16(41.03)	23(58.97)	39(100)	-2.29**
>15	4(14.81)	23(85.19)	27(100)	-10.19***
Mean	**13 (0.98)**	**10 (0.54)**	**11(0.49)**	**2.37****

****P <0.01, ** P<0.05. Values in brackets are percentages*

4.1.5 Level of education

The results in Table 4.5 show that the average level of education of cassava farmers in the study area irrespective of their market participation status was about 7 years with a standard deviation of 0.35. Based on educational level groups, primary education level was the modal group with 94 (62.67%) farmers out of a total 150. Only 12 (8%) cassava farmers in the study area had no formal level of education. In order words, 92% of the respondents had formal level of education suggesting that cassava production in the study area is done by educated farmers. This implies that the respondents' education level in the study area will readily predispose them to adopt modern technologies such as processing machines and high yielding varieties in order to improve their marketing and production activities. The results conform to the findings of Nandi *et al.* (2011) in Obubra LGA of River State, who observed that 86.2% of the sample size of cassava farmers had one form of formal education.

Based on market participation systems, farmers who participated in PCM had about 6 years of education with a standard deviation of 1.03 while those who participated in FCM had about 7 years of education with a standard deviation of 0.37. However, the difference of about a year between the two groups of farmers was insignificant. The implication is that, even though there is a significant difference between both categories in terms of proportions across the defined educational level groups, their exposure in terms of achieving high yield/output, efficient marketing and sustainable cassava production will be the same based on education since they have, on average, the same level of education (Esiobu *et al.*, 2014).

Table 4.5: Distribution of cassava farmers based on level of education and across market participation in Maigana Zone, Kaduna State

Education Level	Market participation PCM (27)	FCM (123)	Total (150)	Z-test
No Formal	3(75)	1(25)	4(100)	2.31**
Primary	20(21.28)	74(78.72)	94(100)	-13.81***
Secondary	3(7.5)	37(92.5)	40(100)	-19.58***
Tertiary	1(8.33)	11(91.67)	12(100)	-10.73***
Mean	**5.93 (1.03)**	**6.84 (0.37)**	**6.67 (0.35)**	**-1.01**

****P<0.02, ** P<0.05. Values in brackets are percentages and standard deviation*

4.1.6 Cropping system

The result in Table 4.6 shows that the majority (73.33%) of cassava farmers in the study area practiced mono-cropping system of farming. This implies that cassava farmers in the study area are more concerned with output maximization which is expected from mono-cropping system of farming at the expense of pest and disease in instances of outbreaks. According to Okigbo (1978) Land as a resource is efficiently utilized through shifting cultivation practices and other cropping systems such as mixed cropping system. Thus, another implication of the finding is that cassava farmers in the study area were not utilizing their land resource efficiently (scale inefficient) and therefore will fail to maximize their profit.

Table 4.6: Distribution of respondents based on cropping systems and across market participation in Maigana Zone, Kaduna State

Cropping System	Market participation PCM (27)	FCM (123)	Total	Z-test
Mono cropping	11 (10)	99 (90)	110(100)	-27.97***
Mixed cropping	16 (40)	24 (60)	40 (100)	-2.58**
Total	27(18)	123(82)	150(100)	

****P<0.01, **P<0.05. Values in brackets are percentages.*

4.1.7 Land size

Evidence in Table 4.7 shows that cassava farmers in the study area used, on average, 1.34 ha of land for the production of cassava with a standard deviation of 0.04. Based on market participation system, cassava farmers who participated in PCM had an average of 1.25 ha against 1.26 for those who participated in FCM with standard deviation of 0.06 and 0.05 respectively. No statistically significant difference was observed between their average farm sizes even though there was a statistically significant difference in terms of proportions of farmers with more than 1 ha of land.

Table 4.7: Distribution of cassava farmers based on land size and across market participation in Maigana Zone, Kaduna State

Land size	Market participation PCM (27)	FCM (123)	Total (150)	Z-test
<=1	16(20)	64(80)	80(100)	-13.42***
>1	11(15.71)	59(84.29)	70(100)	-15.52***
Mean	**1.25 (0.06)**	**1.26 (0.05)**	**1.34 (0.04)**	**-1.08**

****P<0.01. Values in brackets are percentages and standard deviation.*

4.1.8 Credit status

It can readily be seen from Table 4.8 that 89 (59.33%) of cassava farmers in the study area had no access to credit while 61 (40.67%) had access to credit. In order words, the level of access to credit was low among cassava farmers in the study area. It could be that either interest rate on credit was high or farmers lack enough assets that they could used as collateral to acquire loans. According to Oladeebo and Oluwaranti (2012), credit constraint decreases the efficiency of farmers by limiting the adoption of high yielding varieties and the acquisition of information needed for increased productivity. Thus, the implication of the low level of credit is therefore that cassava farmers in the study area would hardly adopt improved varieties which could, in return, reduce their potential profits, *ceteris paribus*. This finding is in concordance with the result of Ugwumba and Omojola (2013), who observed that cassava farmers in Imo State had limited access to credit.

Table 4.8: Distribution of cassava farmers based on access to credit and across market participation systems in Maigana Zone, Kaduna State

	Market participation			
Access to credit	**PCM (27)**	**FCM (123)**	**Total**	**Z-test**
No Access	8 (9)	81 (91)	89 (100)	-27.03***
Access	19 (31.15)	42 (68.85)	61 (100)	-6.42***
Total	**27(18)**	**123(82)**	**150(100)**	

****P<0.01, **P<0.05. Values in brackets are percentages*

4.1.9 Extension service

Basing the analysis across market participation systems, the result in Table 4.9 shows that the proportion of cassava farmers who participated in FCM had significantly more contact with extension agents (82.84%) than their counterparts (17.16%). This implies that cassava farmers who participated in FCM would be more exposed to latest research findings which would enable them utilize their resources more efficiently than their counterparts.

Extension contact has been shown to be a statistically significant explanatory variable determining the adoption of technologies such as soil conservation technologies (Njoku *et al*., 2009). The results in Table 4.10 shows that 134 (89.33%) of cassava farmers in the study area had no access to extension service. The implication of the findings is that the poor extension contact would deprive farmers of access to information on latest research findings and experience which are supposed to be converted to field accomplishments. The finding is in tandem with the results of Iyagba and Anyanwu (2012) who found out that 84.5% of cassava farmers in Oyigbo LGA of Rivers State had no contact with extension agents.

Table 4.9: Distribution of cassava farmers based on contact with extension agents status and across market participation in Maigana Zone, Kaduna State

	Market participation systems			
Extension service	**PCM**	**FCM**	**Total**	**Z-test**
No contact	23(25)	111(75)	134(100)	-4.62***
Contact	4(17.16)	12(82.84)	16(100)	-20.34***
Total	**27(18)**	**123(82)**	**150(100)**	

****P<0.01.   Values in brackets are percentages*

4.1.10 Association membership

Membership of cooperative society affords farmers the opportunity of sharing information on modern production techniques, purchasing inputs in bulk as well as exchanging labour (Ewaonicha, 2005; Onaiwu, 2011; Onubuogu and Onyeneke, 2012; Simonyan *et al*, 2012 and Onubuogu *et al.*, 2013. The result in Table 4.10 shows that, irrespective of market participation systems, 115 (76.67%) cassava farmers in the study area were not members of any form of association. The implication is that efficiency in production and marketing activities of cassava farmers in the study area would be less facilitated. According to Abdoulaye *et al.* (2014) farmers who are not members of associations are expected to have lower probabilities of adoption and a lower level of use of either improved cassava varieties or grating machine. No significant difference was observed between market farmers who participated in PCM and FCM in terms of membership of any association.

Table 4.10: Distribution of respondents based on association membership and across market participation in Maigana Zone, Kaduna State

Association membership	Market participation			
	PCM (27)	FCM (123)	Total	Z-test
Yes	3(8.57)	32(91.43)	35(100)	-0.21
No	24(20.87)	91(79.13)	115(100)	-15.27***
Total	**27(18)**	**123(82)**	**150(100)**	

****P<0.01. Values in brackets are percentages.*

4.1.12 Use of information and communication technology (ICT)

Wolf (2001) found out that ICT use increases the competitiveness of small scale enterprise by facilitating information flows and reducing transaction costs. The result in Table 4.12 shows that 148 (98.67%) cassava farmers did not use ICT for accessing agricultural knowledge and information. The implication is that cassava farmers would be exposed to high transactions costs in acquiring production inputs and marketing of their produce. This finding is confirmed by Ezeh (2013) who found out that ICT use by farmers in South east Nigeria was quite low with average access and use indexes of 1.2 and 1.8 respectively.

Table 4.12: Distribution of cassava farmers based on access to ICT and across market participation in Maigana Zone, Kaduna State

Access to ICT	Market participation systems			
	PCM (27)	FCM (123)	Total	Z-test
Yes	1(50)	1(50)	2(100)	0
No	26(17.57)	122(82.43)	148(100)	-20.27***
Total	**27(18)**	**123(82)**	**150(100)**	

****P<0.01. Values in brackets are percentages.*

4.1.13 Other characteristics

The difference between farmers under PCM and FCM was significant base on cassava output and yield (Table 4.13). In other words, based on the difference-in-means (DIM) estimator method, farmers under PCM appeared to perform averagely better than those in FCMS during the 2013 farming period as, on average, they had a significant difference of 4, 028.93 kg, and 3, 190.7 kg/ha in cassava output, and yield respectively. This preliminary result suggests that PCM had an indirect impact on the cassava output of farmers under PCM. However, this is a strong statement because the DIM method is robust only under certain assumptions such as randomization. It is believed that farmers were not assigned randomly to either the PCMS or FCM category, but rather they had some level of control if not all over their decision to participate in either of the categories and thereby inducing a selection bias which ought to be taken care of before making any rigorous conclusion. Moreover, beside observed factors that may have influenced their choice, unobserved characteristics could be responsible for the observed differences. Thus, a statistical control group must be identified in order to assess the true impact of PCM on cassava output and yield. A stronger method was considered in latter objective in order to obtain a more plausible impact of participation in processed cassava market.

Table 4.13: Descriptive statistics of production outcomes of respondents across market participation in Maigana Zone, Kaduna State

	Market participation			
Production outcomes	**PCM (27)**	**PCM (123)**	**Total**	**Z-test**
Output (kg)	12,152.63 (1103.09)	8,123.69 (567.9)	8,848.91 (520.09)	3.06***
Yield (kg/ha)	10,173.34 (907.39)	6982.65 (708.44)	7,556.97 (610.67)	2.03**

****P<0.01, **P<0.05. Values in brackets are standard deviations.*

4.2 Profitability to Cassava Production

Gross margin analysis method was adopted to examine the difference in profitability of small scale farmers under fresh and processed cassava market participation in the study area on a per hectare basis. First and foremost, by pooling all the cassava farmers together, it was found out that cassava enterprise was profitable during the 2013 farming season in the study area. In effect, as shown in Table 4.14, the average total cost of cassava production was estimated at NGN 91, 089.75 while the average total revenue was estimated at NGN 185, 387.23.

Table 4.14: Average Cost and Return per Hectare for cassava Production

	Market participation				
	PCM (27)	**FCM (123)**	**Difference**	**Total (150)**	**Difference Test**
A. Costs	**Value (NGN)**				
1. Variables Cost					
a- Stem Cutting (kg)	14,136.62	9,600.95	4,535.67	10,417.37	3.30***
b- Fertilizer (kg)	18,495.31	23,653.79	-5,158.48	22,725.26	-1.95*
c- Labour (Man-day)	7,453.74	6,724.78	728.97	6,855.99	1.27
d- Herbicide (Litre)	4,654.96	4,399.23	255.73	4,445.26	0.49
Total Variable Cost (TVC) = (a+b+c+d)	44,740.63	44,378.74	361.89	44,443.88	0.09
2. Fixed Cost					
e- Land Renting	9,959.69	9,150.68	809.02	9,296.30	1.11
f- Depreciation	5,400.00	1,500.00	3,900.00	2,202.00	NA
g- Processing	8,500.00	0.00	8,500.00	8,500.00	NA
Total Fixed Cost (TFC) = (e+f+g)	**23,859.69**	**10,650.68**	**13,209.02**	**46,645.88**	**1.03**
Total Cost (TC) = (TVC+TFC)	68,600.32	55,029.42	13,570.91	91,089.75	0.56
B. Return					
h- Yield (kg/ha)	10,173.34	6,982.65	3,190.70	7,556.97	2.03**
i- Price (NGN/Kg)	29.22	23.50	5.72	24.53	3.27***
Total Revenue (TR) = (h*i)	**297,302.74**	**164,106.47**	**133,196.27**	**185,387.23**	**2.05****
Gross Margin (GM) = (TR-TVC)	252,562.11	119,727.73	132,834.37	140,943.35	2.14**
Net Farm Income (NFI) = (GM-TFC)	228,702.41	109,077.06	119,625.36	94,297.47	2.06**
Net Farm Income on NGN Invested = (TR/TC-1)	**3.33**	**1.98**	**1.35**	**1.04**	**2.13****

****P<0.01, **P<0.05, *P<0.Test-test was employed to test the difference in cost and returns. NA= Not available due to inadequate variability within the data.*

Arithmetically, the difference-in-means between the two estimates gave NGN 94, 297.48 which represented the average net farm income realized by producing cassava on 1 ha of land. Furthermore, the net farm income per NGN 1 invested was NGN 1.04. In other words, by spending N1 in the production of cassava in the study area during the 2013 farming season, an income of NGN 1.04 was realized. This finding is consistent with the results of Nandi (2011) who observed that cassava production is a profitable activity. He found that by investing NGN 1 in cassava production in Cross River State, farmers realized NGN 1.96.

Cassava enterprise was not only profitable among the population of cassava farmers on average, but also across the sub-samples of farmers under the processed and fresh cassava market participation systems in the study area. However, it is necessary to point out that some significant differences were observed in terms of cost of inputs incurred and also in terms of return realized. Although, there was no significant difference across the two groups in terms of total cost incurred in purchasing the production inputs (cassava cuttings, fertilizer, labour, herbicide and land) on average as revealed in Table 5, the average cost of cassava cuttings were significantly greater for farmers under the PCM (NGN 14, 136.62) than that of farmers under FCM (NGN 9, 600.95). Contrarily, the cost of fertilizer was lower for the former (NGN 18, 495.31) than that of the latter (NGN 23, 653.79). In terms of return, while the farmers under the PCM realized NGN 3.33 by spending NGN 1 in the production of cassava, those under FCM realized NGN 1.98 by spending NGN 1 in the production of the crop during the 2013 farming season in the study area. Summarily, small scale farmers who participated in the PCM had a significant increase of NGN 1.35 by spending NGN 1 in the production of cassava in the study area. The result agrees with the findings of Muhammad-Lawal, Omotesho and Oyedemi (2013) who found out that cassava processing, even though it is still food-oriented in Kwara State, was profitable.

4.3 Economic Efficiency Levels of Cassava Farmers

Both technical and allocative efficiency levels are required for the computation of economic efficiency levels. The following shows their estimations.

4.3.1 Technical efficiency levels of cassava farmers

This section presents the models that were used for the computation of the technical efficiency levels of the cassava farmers with respect to their cassava market participation status in the study area.

Three Cobb-Douglas stochastic frontier production function models were estimated. One was estimated using the pooled data of the 150 cassava farmers. The two others were estimated based on data on farmers under the PCM and those on farmers under the FCM in order to estimate their levels of technical efficiency. Firstly, for the purpose of prediction of cassava output and estimation of other characteristics such as technical efficiency levels, a concern was raised on whether a single model estimated based on the pooled sample of farmers should be used so that estimation of the technical efficiency levels of the two groups of cassava farmers (FCM and PCM) would be derived from it. A question of that nature was useful since using one model instead of two different ones is naturally simpler for prediction or policy design. However, by choosing one model over two, an implicit imposition is made concerning the constancy or stability of the models' parameters (intercepts and slopes) across the two groups of cassava farmers. A single model of that kind is called a restricted model (Gujarati, 2003).

A show-test type using Stata 12 statistical package was therefore conducted to examine the stability of the parameters of cassava production function in Maigana zone across both groups of farmers. Based on likelihood ratio test as evident the chi-square value of the test under the null hypothesis of nested models was 25.47 with a p-value of 0.0006. The test was thus significant and the null hypothesis of nested models was rejected. In other words, modeling cassava output using different stochastic frontier function models for both categories of farmers to estimate their levels of technical efficiency was justified and better than the restricted model.

4.3.1.1 Technical efficiency levels of cassava farmers under PCM

In order to estimate the technical efficiency levels of cassava farmers who participated in PCM, a stochastic frontier Cobb-Douglas production function was fitted. Table 4.15 shows the maximum likelihood estimates of the parameters of the stochastic frontier Cobb-Douglas production function for cassava production of the farmers who participated in PCM in the study area. An overview of the model shows that six input factors were considered: land, cassava cuttings, hired labour, family labour, fertilizer and herbicide. A priori, these input factors, individually, were expected to influence cassava output positively and significantly.

The result presented in Table 4.15 showss that the estimate of sigma square is 0.39 and is significant at 1% level of probability; this implies that technical inefficiency effects are present in the production of cassava among farmers under the PCM in the study area. It also means a good fit of the model and correctness of the distributional assumption (half normal) of the inefficiency term. The hypothesis that gamma is equal to zero was rejected at 1% level of probability. The estimated value of gamma is about 1 which implies that about 100% of total variation in cassava output in the study area among farmers who participated in PCM is due to differences in technical inefficiency. This is also to say that stochastic frontier Cobb-Douglas production function is better in modelling cassava output in the study area than the classical production function models such as Cobb-Douglas, semi-log or exponential regression models. The result is consistent with the findings of Onubuogu *et al.* (2014) who revealed that about 98% of variation in cassava production in Imo State was due to technical inefficiency.

Land and hired labour were the two input factors that were not statistically significant in terms of explaining variation in cassava output. Although family labour, fertilizer and herbicide were statistically significant in terms of explaining variation in cassava output, their sign was inconsistent with the a priori expectation. Only cassava cuttings were fully consistent with the a priori expectation.

Table 4.15: Maximum likelihood estimates of the parameters of the stochastic frontier Cobb-Douglas production function for cassava production of the farmers under processed cassava market participation in Maigana Zone

Factors	**Parameters**	**Coefficients**	**Std. Error**	**Z-Value**
Intercept	β_0	19.91	0.98	20.28***
Land	β_1	0.27	0.25	1.06
Cassava cuttings	β_2	1.68	0.15	4.59***
Hired labour	β_3	0.08	0.13	0.61
Family labour	β_4	-0.22	0.06	-3.61***
Fertilizer	β_5	-0.07	0.01	-8.13***
Herbicide	β_6	-0.43	0.24	-1.83*
Model's goodness of fit				
Sigma square		0.39	0.09	4.56***
Gamma		0.99	0.00	56.63***
Log likelihood function		-7.79		
Likelihood ratio test		13.75		
Return to scale		**1.31**		
Mean technical efficiency		**0.68**		
Number of Observation		27		

****P<0.01, *P<0.1. Variables in the model are in logarithm form*

Land remains the single most important factor of agricultural production. But its insignificant impact on cassava output could be explained by the fact that given existing technologies it would be uneconomic to drive productivity through increases in farm size (Okezie, Ahuchuogu and Jamalludin, 2012). The result lends credence to the findings of Hristov (2009) who found out that land size had positive but insignificant impact on the production of vegetables in Macedonia. According to Hritov (2009) the main reason for the result may be explained by the fact that most of the observed farms were cultivated on almost similar acreage. Hence, land probably is not able to be taken into consideration in the prediction of cassava output among those who participated in PCM. Another possible explanation of the insignificance of land in cassava production as explained by Verbeek (2004) is that multicolinearity caused by the high correlation between land size and the other inputs in the model could be responsible of the insignificance of land size.

The positive and significant effect of cassava cuttings on cassava output is consistent with the a priori expectation. The implication of the finding is that an increase in cassava cuttings by 1% will lead, on average, to an increase of about 1.3% in cassava output, *ceteris paribus*. This result agrees with the findings of Anyanwu, Kalio, Olatunji and Akonye (2014) in Rivers State who stated that cassava output in the study area was positively and significantly inelastic with respect to stem cuttings.

Hired labour was found to be positive but insignificantly related to cassava output; this implies that by increasing hired labour by 1% of man-day, on average, cassava output will insignificantly increase by about 0.1%, *ceteris paribus*. According to Olayide *et al.* (1980), there is an inverse relationship between family labour and hired labour. The insignificant effect of hired labour could be explained by the fact that family labour was probably enough to satisfy the total labour requirement due to high household size as previously observed and that the little quantity of extra labour hired did not bring about any significant contribution. The result is consistent with the study of Usman and Bakari (2013) who found out that, although hired labour was negative, it was insignificant in the production of dry season tomato in Adamawa State.

The use of family labour was found to have a negative and significant relationship with cassava output. The implication is that increasing family labour by 1%, on average, will result in a reduction of about 0.2%, *ceteris paribus*. This result is inconsistent with the a priori expectation in terms of the direction of influence on cassava output. According to

Usman and Bakari (2013) it could be that farmers misused resources by engaging unskilled, immature and uninterested family members that resulted in reduction in efficiency and output. This result is in tandem with the findings of Usman and Bakari (2013) who reported that dry season tomato production in Adamawa State was negatively influenced by family labour.

Table 19 shows that cassava output was negatively and significantly related to fertilizer; this implies that by increasing fertilizer by 1%, cassava output will be reduced, on average, by about 0.6%, *ceteris paribus.* The significance of the input is consistent with a priori expectation in terms of significance, but the direction of the relationship with cassava output is not. Fertilizer when used at the optimal level improves soil fertility while its overuse damages it (Eze and Nwibo, 2014). Thus, it could be that cassava farmers who participated in PCM used fertilizer beyond the required level which later led to soil acidity and binding of certain important micro and macro nutrients that are needed for optimum crop growth. The result is in conformity with the findings of Onubuogu *et al.* (2014), who reported that fertilizer was negatively and significantly related to cassava output in Owerri Agricultural Zone, Imo State.

The coefficient of herbicide was negative but significantly related to cassava output; this implies that increasing herbicide by 1%, on average, will result in a reduction of about 0.4% in cassava output, *ceteris paribus*. The direction of the relationship was contrary to the a priori expectation. Herbicide is often used by farmers for weed control. The quality of water used in spray tanks can affect herbicide efficacy (Hall, Hart and Jones, 1999). Thus, a possible explanation of the finding is that, water used in dissolving herbicide had high pH which contributed to a fast dissolution of herbicide which in turn became negatively charged and then impacted negatively on cassava output. The result is in line with the findings of Eze and Nwibo (2014) who found out that increasing herbicide by 1%, on average, significantly reduced cassava output by about 5%, *ceteris paribus.*

The estimate of the return to scale parameter, sometimes called the function coefficient is about 1.3; this implies that cassava production among farmers who participate in PCM exhibits an increasing return to scale. In order words, if for instance, all inputs turn out to be variable in the long run and are increased by 1%, the quantity of cassava output will be increased by more than 1%, *ceteris paribus*. The result equally implies that cassava farmers under PCM are still in stage one of the classical production function and are not therefore utilizing their resources efficiently. In order words, increase in technical efficiency would result in reduction of quantity of input used. The result is consistent with the findings of Ogunbameru and Okeowo (2013) who reported that cassava production in Epe area of Lagos State exhibited an increasing return to scale.

The estimated average level of technical efficiency is 0.68. This implies that cassava farmers who participated in PCM produced, on average, cassava output at 68% of their potentials. In order words there is still room for improvements with the current levels of resources and technology. Further interpretation is provided in below.

4.3.1.2 Technical efficiency levels of cassava farmers under FCM

The estimation of the technical efficiency levels of cassava farmers who participated in FCM required the fitting of a stochastic frontier Cobb-Douglas production function. Table 4.16 shows the maximum likelihood estimates of the parameters of the stochastic frontier Cobb-Douglas production function for cassava production of the farmers who participated in FCM in the study area. An overview of the model shows that six input factors were considered: land, cassava cuttings, hired labour, family labour, fertilizer and herbicide. A priori, these input factors, individually, were expected to influence cassava output positively and significantly.

The hypothesis that gamma is equal to zero was rejected at 1% level of probability confirming the presence of inefficiency term. The estimated value of gamma is about 1 which implies that about 100% of total variation in cassava output in the study area among farmers who participated in FCM is due to technical inefficiency. This is also to say that stochastic frontier Cobb-Douglas production function is better in modelling cassava output among this set of farmers than the classical production function models such as Cobb-Douglas, semi-log or exponential regression models. The overall finding suggests that cassava production in the entire study area is influenced by technical inefficiency. The result is consistent with the findings of Onubuogu *et al.* (2014) who revealed that about 98% of variation in cassava production in Imo State was due to technical inefficiency.

Table 4.16: Maximum likelihood estimates of the parameters of the stochastic frontier Cobb-Douglas production function for cassava production of the farmers who participated in fresh cassava market in Maigana Zone

Factors	Parameters	Coefficients	Std. error	Z-Value
Intercept	β_0	9.91	1.79	5.53***
Land	β_1	-0.16	0.21	-0.78
Cassava cuttings	β_2	0.20	0.14	1.47
Hired labour	β_3	1.86	0.10	8.49***
Family labour	β_4	-1.59	0.13	-4.60**
Fertilizer	β_5	0.07	0.11	0.67
Herbicide	β_6	-0.20	0.14	-1.43
Model's goodness of fit				
Sigma squared		1.64	0.26	6.38***
Gamma		0.99	0.01	75.92***
Log likelihood function		-127.97		
Likelihood ratio test		25.02		
Return to scale		**1.18**		
Mean technical efficiency		**0.46**		
Number of observation		123		

****P<0.0.1. Values in the model are in logarithm form.*

Land, cassava cuttings, fertilizer and herbicide were not statistically significant in terms of explaining variation in cassava output. Although family labour was significantly related to cassava output, its sign was inconsistent with the a priori expectation. Only hired labour was fully consistent with the a priori expectation.

Land was not significantly related to cassava output. As previously explained, it could be as a result of the fact that cassava farmers cultivated similar acreages of land and therefore land became a weak predictor of cassava output (Hritov, 2009). This is also to say that the lack of variation in land cultivated can affect the significance of the input in predicting output.

Cassava cuttings were consistent with the a priori expectation in terms of direction of influence but were insignificantly related to cassava output. The production of cassava is dependent on a supply of quality stem cuttings (IITA, 2009). It could be that the cassava cuttings used by farmers in the study area are not of good quality and as such are unable to significantly increase cassava output among farmers who participated in FCM. This is also to say that growth in cassava output cannot be improved with the current quality and perhaps the method of utilization of the cassava cuttings available to the farmers. The finding corroborates the result of Onoja, Ibrahim and Achike (2010) who reported that cassava cuttings were insignificantly related to cassava production in Kogi State. According to the authors, the insignificance of cassava cuttings in predicting cassava output was due to the farmers’ planting spacing and the poor variety used.

Because of the tedious and rigorous nature of cassava production, more borrowed and hired labour are sought for as a supplement to family labour by farmers (Nsikan, Aniekan and Udoro, 2005). Hired labour was positively and significantly related to cassava production in the study area for farmers who participated in FCM; this implies that if hired labour increases by 1%, on average, cassava output will increase by about 0.9%, *ceteris paribus*. The result is consistent with the a priori expectation. Similar findings can be obtained from the works of several authors such as Nsikan, Aniekan and Udoro (2005); Achoja, Idoge, Ukwuaba and Esowhode (2012) and Bassey and Okon (2008) who reported that cassava production was labour intensive in their respective areas of study.

Family labour was significantly, although negatively, related to cassava production in the study area among farmers who participated in FCM; this implies that if family labour increases by 1%, on average, cassava output will be reduced by about 0.6%, *ceteris paribus*. The finding is not consistent with the a priori expectation in terms of direction of influence on cassava output. As previously observed among farmers who participated in PCM, it could be that farmers who participated in FCM also misused resources by engaging unskilled, immature and uninterested family members that resulted in reduction in efficiency and output (Usman and Bakari, 2013). The implication of the findings is that family labour was over utilized probably due to the small parcel of land cultivated and the large family size.

The quantity of fertilizer used was insignificantly related to cassava output. The result is not consistent with the a priori expectation. Fertilizer is viewed in the literature as a land augmenting technology. A possible implication of the its insignificant effect on cassava output among farmers who participated in FCM is that they were not using the right agronomic practice since the average quantity of fertilizer used was quite above the national average of 13kg/ha (IFPRI, 2010). The result is in concordance with the findings of Awoyinka (2009) who reported that fertilizer was insignificantly related to cassava production of farmers who participated in the Presidential Initiatives on Cassava (PIC) in Oyo State.

Herbicide was negatively and insignificantly related to cassava production; this implies that cassava does not respond to changes in herbicide use in the study area. This is contrary to the a priori expectation. Herbicides are by far cheaper and more readily available than labour for hand weeding and therefore helps improving yields (Crop Life Foundation, 2013). Its insignificant effect on cassava production could be attributed to the fact that farmers in the study area were poorly assisted by extension agents in the use of herbicide as it was descriptively observed that 111 (90.24%) cassava farmers out of the 123 who participated in FCM did not have contact with extension agents. This result is in tandem with the findings of (Aboki, 2013) who found out that agrochemicals were insignificantly related to cassava output in Taraba State (Aboki, jongur, Onuand and Umaru, 2013).

The estimate of the return to scale parameter is 1.18; this implies that cassava production among farmers who participated in FCM exhibits an increasing return to scale. Cassava production is therefore at stage one of the production surface. If all inputs turn out to be variable in the long run and are increased by 1%, the quantity of cassava output among farmers who participated in FCM will be increased, on average, by more than 1%, *ceteris paribus*. By increasing the variable inputs, farmers would still be able to make more profits since average output per variable input is expected to increase at this stage, *ceteris paribus*. The result is consistent with the findings of Ogunbameru and Okeowo (2013) who reported that cassava production in Epe area of Lagos State exhibited an increasing return to scale. In sum, it can be said that cassava production in the entire study area exhibits a decreasing return to scale irrespectively of the type of market participation system.

The estimated average level of technical efficiency is 0.68. This implies that cassava farmers who participated in PCM produced, on average, cassava output at 46% of their potentials. In order words, there is still room for improvements in the quantity of cassava output with the current levels of resources and technology. Further discussions are provided below.

4.3.1.3 Distribution of cassava farmers under PCM and FCM based on the deciles of their technical efficiency levels

Table 4.17 presents the results of the distribution of cassava farmers in the study area based on the deciles of their levels of technical efficiency. The estimated technical efficiency levels of the farmers were first categorized using decile classes of the data as boundaries before comparisons were subsequently made across market participation systems and over the categories of the deciles of the level of technical efficiency obtained.

The results in Table 4.17 show that the proportion of farmers who participated in the FCM was significantly higher at 1% level of probability than the proportion of those who participated in the PCM across the 2nd, 6th, 7th, 8th and 9th classes. However, the proportion of farmers over both market participation systems was insignificantly different across the 3rd, 5th, and 10th classes while in the 1st decile the comparison was not possible due to the fact that no farmer who participated in the PCMS was observed in this category.

Table 4.17: Distribution of cassava farmers based on the deciles of their technical efficiency levels in the study area

	Market Participation					
	PCM		FCM			
Decile classes	Frequency	Percentage	Frequency	Percentage	Total	Difference test
0 - 0.16	0	0	15	100.00	15	
0.17 - 0.27	2	10.53	17	89.47	19	-10.87***
0.28 - 0.35	1	9.09	10	90.91	11	-0.12
0.36 - 0.4	1	5.26	18	94.74	19	L -9.00
0.41 - 0.45	1	8.33	11	91.67	12	-1.53
0.46 – 56	4	25.00	12	75.00	16	-4.62***
0.57 - 0.67	4	28.57	10	71.43	14	-3.46***
0.68 - 0. 77	3	20.00	12	80.00	15	-5.81***
0. 78 - 0. 86	4	28.57	10	71.43	14	-3.46***
0.87 – 1	7	46.67	8	53.33	15	-0.47
Mean	**0.68**		**0.46**			**4.11*** **
Standard Deviation	0.24		0.25			
Minimum	0.16		0.04			
Maximum	9.8		0.95			

****P<0.01*

The results in Table 4.17 reveal that the average level of technical efficiency of cassava farmers who participated in the PCM was 0.68 with a standard deviation of 0.24. This implies that an average farmer under the FCM can still improve his current level of technical efficiency by 32% with the current levels of technology and inputs. In order words, if an average cassava farmer within this category is to be fully efficient, then he/she could experience an increase in cassava output of about 32%. For those who participated in FCM, the average level of technical efficiency was 0.46 with a standard deviation of 0.25. This means that if an average farmer within this category is to be fully efficient, then he/she could experience an increase in cassava output of about 54% *ceteris paribus*. The difference in average level of technical efficiency across both market participation systems was significant at 1% level of probability. This is to say that farmers under the PCM are, on average, more technically efficiency than their counterparts, *ceteris paribus*.

The minimum and maximum technical efficiency levels of cassava farmers who participated in PCM were 0.16 and 0.98 respectively. The implication is that the less efficient cassava farmer within this category can still improve his current level of output by 0.84% if he is to become fully efficient while the most efficiency can only increase his by 2% with the available level of technology and inputs. For the cassava farmers who participated in FCM, The minimum and maximum technical efficiency levels were 0.04 and 0.95 respectively. The implication is that the less efficient cassava farmer within this category can still improve his current level of output by 0.96% while the most efficiency one can only increase his by only 5% with the current technology and input levels.

4.3.2 Allocative efficiency levels of cassava farmers

This section presents the models that were used for the computation of the allocative and levels of the cassava farmers in the study area.

Three stochastic frontier cost functions were estimated: for the pooled data, farmers who participated in PCM and FCM. Translog and Cobb-Douglas models were fitted for each model and the best models were retained. The following gives details of the choice of the models retained for further analysis. The results of the Wald test for the significance of the square and interaction terms in the translog models was conducted in order to examine whether or not the translog specification of cost functions was better than the Cobb-Douglas form to predict the cost of cassava production in the study area. That was equivalent to testing the null hypothesis that the square and interaction terms as shown in Table 22 were unimportant in terms of predicting the cost of cassava production and also the levels of allocative efficiency of the farmers. Based on the values of chi-squared statistic computed for each of the models, it turned out that, only the translog specification of the cost function for the pooled data was better that that of the Cobb-Douglas since the chi-square statistic under the assumption of no influence of the square and interaction terms was significant at 5% level of probability each. However, for the case of farmers under the PCM and FCM, the Cobb-Douglas stochastic frontier cost functions were found to be equivalent to the translog form since the test was insignificant due to the low value of chi-square statistic or high p-value.

A show-test type was further conducted to investigate whether or not the stochastic frontier translog cost function of the pooled data was significantly better than the two stochastic frontier Cobb-Douglas cost functions of the farmers under PCM and FCM in estimating the allocative efficiency levels. The null hypothesis was that the two stochastic frontier Cobb-Douglas cost functions of the farmers across both cassava market participation systems were nested in the stochastic frontier translog cost function for the pooled data. The test was found to be significant on the basis of the likelihood ratio test conducted. In effect, the chi-square value of the test was very high, about 409.47. It was therefore advocated that separate stochastic frontier Cobb-Douglas cost functions were to be fitted for farmers under PCM and FCM before obtaining efficiency estimates than to use the restricted pooled translog model.

4.3.2.1 Allocative efficiency levels of cassava farmers under PCM

Table 4.18 shows the maximum likelihood estimates of the parameters of the stochastic frontier Cobb-Douglas cost function for cassava production of the farmers who participated in PCM in the study area. An overview of the model shows that seven independent variables were used for the prediction of the total cost of cassava production and thus estimation of their levels of allocative efficiency. These variables are: cassava output, average cost of land, average cost of cassava cuttings, average cost of hired labour, average cost of family labour, average cost of fertilizer and the average cost of herbicide. A priori, the regressors were individually expected to influence the total cost of cassava output positively and significantly.

The variance of the composite error term (sigma square) is 0.004 and is significant at 1% level of probability; this implies that the stochastic frontier Cobb-Douglas cost function was well fitted with a correct specification of the distributional assumption (half normal) for the inefficiency term. The gamma value was about 1 and was significant at 1% level of probability; this implies cost inefficiency effects were present in the production of cassava and that about 100% of variation in the total cost of cassava production was due to the famers' differences in cost inefficiency. This is also to say that stochastic frontier Cobb-Douglas cost function is better in modelling the total cost of cassava production among this set of farmers than the classical cost function models with a given specification such as Cobb-Douglas, semi-log or exponential. These findings are consistent with the results of Audu *et al.* (2013) who observed that about 96% of variation in total cost of cassava production in Kogi state among cassava farmers was due to their levels of inefficiency.

Table 4.18: Maximum likelihood estimates of the parameters of the stochastic frontier translog cost function for cassava production of the farmers under processed cassava market participation in Maigana Zone

Factors	Parameters	Coefficients	Std. Errors	T-Statistics
Intercept Term	α_0	4.04	0.91	4.42***
Cassava output	δ	0.01	0.02	0.44
Average cost of land	α_1	0.20	0.04	5.33***
Average cost of seed	α_2	0.00001	0.000002	7.67***
Average cost of fertilizer	α_3	0.28	0.01	19.80***
Average cost of herbicide	α_4	0.01	0.02	0.58
Average cost of hired Labour	α_5	0.15	0.09	1.76*
Average cost of family Labour	α_6	0.08	0.05	1.67*
Model Goodness of Fit				
Sigma Square		0.004	0.001	5.16***
Gamma		0.99	0.03	28.99***
Mean Allocative Efficiency		**0.95**		
Log likelihood function		44.988**		
Likelihood ratio test		6.34		
Number of observation		27		

****P<0.01, **P<0.05, *P<0.1. All the factors in the model are in natural logarithm form.*

An overview of the model shows that all the average costs of the inputs included in the model were positively and significantly related to the total cost of cassava production for farmers who participated in the PCM except that of herbicide. Cassava output was equally positively but insignificantly related to the total cost of cassava production. The estimate of the constant term was about 4.04 and was significant at 1% level of probability. This is as a result of the fact that expenses on fixed factors of production such as land, farm machineries and tools, buildings, farm roads and other permanent structures would keep running whether or not production takes place (Saudu, *et al.*, 2013). This is in agreement with the findings of Ogundari and Ojo (2006) who obtained a coefficient of 3.56 for the constant term in their study on cassava production in Osun State. The following gives a detailed explanation of the regressors in the model.

Cassava output was positively and significantly related to the total cost of cassava output; this implies that by increasing land size by 1%, the total cost of cassava production in the study area, on average, will be increase by 0.01%, *ceteris paribus*. The results is consistent with the findings of Okoye, Onyenweaku and Asumugha (2007) who observed that cocoyam output was positively and insignificantly related to the total cost of cocoyam production in Anambra State.

The cost of land was positively and significantly related to the total cost of cassava output, this implies that the by increasing the average cost of land by 1%, on average, the total cost of cassava will be increased by 0.2%, *ceteris paribus*. The result is consistent the findings of Akpan, Okon, Jeiyol, Nkeme and John (2013) who the average cost of land was positively and significantly related o the total cost of cassava production among farmers in Southern Wetland region of Cross River State. The cost of seed was positively and significantly associated at 1% level of probability with the total cost of cassava production; this implies that increasing the cost of seed by 1% will lead, on average, to an increase of 0.11% in the total cost of cassava production, *ceteris paribus*. This is also to say that the total cost of cassava production is inelastic with respect to the average cost of seed. The results is consistent with the findings of Audu, Otitolaiye and Ibitoye (2013) who reported that cassava cuttings were positively and significantly related to the total cost of cassava production in Kogi State.

The average cost of fertilizer was positively and significantly related at 1% level of probability to the total cost of cassava production for farmers who participated in the PCM; this implies that an increase in the average cost of fertilizer of 1% will result, on average, in an increase of about 0.28% in the total cost of cassava production, *ceteris paribus*. In order words, the total cost of cassava production is inelastic with respect to the average cost of fertilizer. The finding is consistent with the result of Audu *et al* (2013) who found out that the average cost of fertilizer was positively and significantly related to the total cost of cassava production in Kogi State.

The average cost of herbicide was positive but insignificant related to the total cost of cassava production. This is to say that changes in the average cost of fertilizer, on average, will not cause changes in the total cost of cassava production among farmers who participated in the PCM. The result is in conformity with the study of Ambali, Adegbite, Ayinde and Idowu (2012) who observed that average cost of herbicide in insignificantly related to the total cost of food crops for farmers in Ogun State.

The average cost of hired labour was positively and significantly related to the total cost of cassava production for the farmers who participated in the PCM; this implies that by increasing the cost of hired labour by 1%, on average, the total cost of cassava production will be increase by 0.15%, *ceteris paribus.* The result is in tandem with the findings of Girei, Dire, Iliya and Salihu (2013) who observed that the average cost of hired labour was statistically significant in terms of explaining the total cost of farm crops among Fadama II farmers in Adamawa State.

The average cost of family labour was positively and significantly related to the total cost of cassava production. This implies that by increasing family labour by 1%, on average, the total cost of cassava production for farmers under the PCM will be increased by 0.08%, *ceteris paribus*. The result is equally consistent with the findings of Girei *et al.* (2013) who observed that the total cost of farm crops was statistically inelastic with the average cost of family labour among Fadama II farmers in Adamawa State.

The average level of allocative efficiency in cassava production for farmers who participated in PCM is 0.95. This suggests that the farmers under PCM were highly efficient in terms allocating their resources conditional on the price of the inputs.

4.3.2.2 Allocative efficiency levels of cassava farmers under FCM

Table 4.19 shows the maximum likelihood estimates of the stochastic frontier Cobb-Douglas cost function for cassava production under FCM in the study area. An overview of the model shows that seven independent variables were used for the prediction of the total cost of cassava production and thus estimation of their levels of allocative and economic efficiency. These variables are: cassava output, average cost of land, average cost of cassava cuttings, average cost of hired labour, average cost of family labour, average cost of fertilizer and the average cost of herbicide. A priori, the regressors were individually expected to influence the total cost of cassava output positively and significantly.

The variance of the composite error term (sigma square) is 0.01 and is significant at 10% level of probability; this implies that the stochastic frontier Cobb-Douglas cost function was well fitted with a correct specification of the distributional assumption (half normal) for the inefficiency term. The gamma value was about 1 and was significant at 1% level of probability; this implies cost inefficiency was significantly present in the production of cassava output by farmers under the FCM and that about 100% of variation in the total cost of cassava production was due to the famers' differences in cost inefficiency. This is also to say that stochastic frontier Cobb-Douglas cost function is better in modelling the total cost of cassava production among this set of farmers than the classical cost function models such as Cobb-Douglas, semi-log or exponential regression models. These findings are consistent with the results of Audu *et al.* (2013) who observed that about 96% of variation in total cost of cassava production in Kogi state among cassava farmers was due to their levels of inefficiency.

Table 4.19: Maximum likelihood estimates of the parameters of the stochastic frontier Cobb-Douglas cost function for cassava production of the farmers under fresh cassava market participation in Maigana Zone

Factors	Parameters	Coefficients	Std. Errors	T-Statistics
Intercept Term	α_0	2.68	0.99	2.72***
Cassava output	δ	0.01	0.01	0.80
Cost of land	α_1	0.25	0.08	3.09***
Cost of seed	α_2	0.11	0.04	3.22***
Cost of fertilizer	α_3	0.39	0.07	48.78***
Cost of herbicide	α_4	0.08	0.04	1.90*
Cost of hired Labour	α_5	0.03	0.18	0.15
Cost of family Labour	α_6	0.003	0.05	0.07
Model Goodness of Fit				
Sigma Square		0.01	0.01	1.76*
Gamma		0.99	0.22	4.54***
Allocative Efficiency		**0.92**		
Log likelihood function		153.60		
Likelihood ratio test		47.45		
Number of observation		123		

****P<0.01, **P<0.05, *P<0.1. All the factors in the model are in natural logarithm form.*

An overview of the model shows that all the average costs of the inputs included in the model were positively related to the total cost of cassava production for farmers who participated in the PCM. Hired labour and family labour are the two inputs whose average costs were insignificantly related to the total cost of cassava production. Cassava output was equally positively but insignificantly related to the total cost of cassava production.

The estimate of the constant term is about 2.68 and is significant at 1% level of probability. As previously explained, this is could that as a result of the fact that expenses on fixed factors of production such as land, farm machineries and tools, buildings, farm roads and other permanent structures would keep running whether or not production takes place (Saudu, *et al.*, 2013). This is in agreement with the findings of Ogundari and Ojo

(2006) who obtained a positive and significant intercept term in their study while modeling the total cost of cassava production in Osun State. The following gives a detailed explanation of the regressors in the model.

Cassava output was positive but insignificantly related to the total cost of cassava output as mentioned above; this implies that the total cost of cassava production is not affected by changes in the quantity of cassava output produced. The results is consistent with the findings of Okoye, Onyenweaku and Asumugha (2007) who observed that cocoyam output was positively and insignificantly related to the total cost of cocoyam production in Anambra State.

The cost of land was positively and significantly related to the total cost of cassava output, this implies that the by increasing the average cost of land by 1%, on average, the total cost of cassava will be increased by 0.25%, *ceteris paribus*. The result is consistent with the findings of Akpan *et al.* (2013) who observed that the average cost of land was positively and significantly related to the total cost of cassava production among farmers in Southern Wetland region of Cross River State.

The cost of seed was positively and significantly associated at 1% level of probability with the total cost of cassava production; this implies that increasing the cost of seed by 1% will lead, on average, to an increase of 0.11% in the total cost of cassava production, *ceteris paribus*. This is also to say that the total cost of cassava production is inelastic with respect to the average cost of seed among farmers under the FCM. The results is consistent with the findings of Audu, Otitolaiye and Ibitoye (2013) who reported that cassava cuttings were positively and significantly related to the total cost of cassava production in Kogi State.

The average cost of fertilizer was positively and significantly related at 1% level of probability to the total cost of cassava production for farmers who participated in the PCM; this implies that an increase in the average cost of fertilizer by 1% will result, on average, in an increase of about 0.39% in the total cost of cassava production, *ceteris paribus*. In order words, the total cost of cassava production is inelastic with respect to the average cost of fertilizer. The finding is consistent with the result of Audu *et al* (2013) who found out that the average cost of fertilizer was positively and significantly related to the total cost of cassava production in Kogi State.

The average cost of herbicide was positively and significantly related to the total cost of cassava production; this implies that by increasing the average cost of herbicide by 1%, on average, the total cost of cassava production will be increased by 0.08%. The result is consistent with the findings of Ogundari *et al* (2007) who observed that the average cost of agrochemical was positively and significantly related to the total cost of cassava production among cassava farmers in Osun State.

The average level of allocative efficiency in cassava production for farmers who participated in FCM is 0.92. This suggests that these farmers were highly efficient in terms allocating their resources conditional on the price of the inputs.

4.3.3 Distribution of cassava farmers under PCM and FCM based the deciles of their levels of economic efficiency

The two previous sections dealt with the estimation of the technical and allocative efficiency levels of small scale farmers under the PCM and FCM which were further used for the estimation of their levels of economic efficiency. Economic efficiency level is the product of technical efficiency level and allocative efficiency level.

The distribution of farmers based on the deciles of economic efficiency level is presented in Table 4.20. The average level of economic efficiency of the farmers under the PCM was 0.65 while that of the farmers under the FCM was 0.43. This means that if an average cassava farmer under PCM and FCM are to become fully economically efficient, then their cost of production could be reduced by 35 and 57% level respectively, *ceteris paribus*. A straightforward comparison of the levels of economic efficiency of the farmers under PCM and FCM on the basis of a T-test was undertaken. On average, the economic efficiency level of farmers under the PCM was significantly greater at 1% level of probability than that of farmers under the FCM.

Table 4.20: Distribution of cassava farmers based on the deciles of their economic efficiency levels in the study area

	Market Participation				
	PCM (27)		FCM (123)		
Decile classes	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Difference test**
0.04 - 0.12	0	0	15	100	NA
0.13 - .23	1	6.67	14	93.33	-3.37***
0.24 - 0.314	2	13.33	13	86.67	-8.52
0.315 - 0.35	0	0	15	100	NA
0.36 - 0.40	2	13.33	13	86.67	-8.52***
0.41 - 0.494	0	0	15	100	NA
0.495 - 0.63	5	33.33	10	66.67	-2.80***
0.64 - .71	1	6.67	14	93.33	-3.37***
0.72 -0.81	5	33.33	10	66.67	-2.80***
0.82 – 1	7	46.67	8	53.33	-7.59***
Mean	**0.65**		**0.43**		**4.20*** **
Standard Deviation	0.24		0.24		
Minimum	0.14		0.04		
Maximum	0.96		0.91		

****P<0.01. NA = Not Available due to no observations*

The results show that farmers under the FCM were proportionally more than their counterparts across the 2nd, 3rd, 5th, 6th, 7th, 8th, 9th and 10th decile classes of their level of technical efficiency levels. Across the 1st, 4th and 6th decile classes the comparison was not conducted since no data for the farmers under PCM was available. The implication is that even though farmers under the PCM are, on average, more economically efficient than those under the FCM, based on deciles however, the reverse seems to be the case.

The minimum and maximum economic efficiency levels of cassava farmers who participated in PCM were 0.14 and 0.96 respectively. The implication is that the less economically efficient cassava farmer within this category can still reduce his cost of production by 0.86% if he is to become fully economically efficient while the most economically efficiency one can only reduce his by 0.4% while maintaining the same level of production. For the cassava farmers who participated in FCM, The minimum and maximum economic efficiency levels were 0.04 and 0.91 respectively. The implication is that the less efficient cassava farmer within this category can still reduce his cost of production by 0.96% while the most efficiency one can only reduce his by only 9% with the current technology and input levels.

4.3.3.1 Economic efficiency levels across some socioeconomic characteristics

The economic efficiency levels of the farmers under PCM and FCM were equally compared after accounting for some factors such as marital status, level of education, access to credit, cropping system, and land size (Table 4.21).

Based on marital status, it was observed that married farmers under the PCM and FCM had an economic efficiency level of 0.64 and 0.45 respectively. The difference in their economic efficiency levels was found to be statistically significant at 1% level of probability. Considering the subset of farmers who were unmarried, the farmers under the PCM and FCM had an average economic efficiency level of 0.72 and 0.48 respectively with no significant difference. The implication is that farmers under the PCM were more economically efficient than those under the FCMS based on marital status.

Based on education level, farmers under the PCM and FCM with less than a primary level of education had an average economic efficiency level of 0.62 and 0.46 respectively. The difference was found to be statistically significant at 5% level of probability. Considering the stratum of farmers with more than primary level of education, farmers under the PCM and FCM had an average economic efficiency level of 0.68 and 0.45 respectively. The difference was significant at 1% level of probability. The implication of this result is that farmers under the PCM were statistically more economically efficient than those under the FCM based on level of education.

Table 4.21: Difference in economic efficiency of small scale farmers under different cassava market participation systems based on some socioeconomic characteristics in Maigana Zone, Kaduna State

	Market Participation			
Characteristics	**PCM (27)**	**PCM (123)**	**Differences**	**Difference Test**
Marital Status				
Married	0.64 (0.05)	0.45 (0.02)	0.18	3.31***
Unmarried	0.72 (0.12)	0.48 (0.11)	0.25	1.54
Level of Education				
<= Primary Education	0.62 (0.06)	0.46 (0.04)	0.16	2.1**
> Primary Education	0.68 (0.06)	0.45 (0.03)	0.23	3.1***
Land Size				
Land<=1	0.72 (0.12)	0.48 (0.11)	0.25	1.50
Land>1	0.66 (0.07)	0.47 (0.03)	0.19	2.5***
Cropping System				
Mono	NA	NA	NA	NA
Mixed	0.61 (0.05)	0.44 (0.03)	0.17	2.88***
Access to credit				
No Access	0.66 (0.06)	0.43 (0.03)	0.23	3.3***
Access	0.63 (0.08)	0.47 (0.03)	0.16	1.89*

****P<0.01, **P<0.05, *P<0.1. All the factors in the model are in natural logarithm form. T-test was used to examine the significance of the differences. Values in brackets are standard errors. NA= Not available because of insufficient observations*

Based on land size under cassava cultivation, farmers under the PCM and FCM had an average economic efficiency level of 0.72 and 0.48 respectively with no significant difference. However the levels of economic efficiency levels of farmers under PCM and FCM across the subset of farmers with more than 1 ha of land were 0.66 and 0.47 respectively with a difference which was found to be statistically significant at 1% level of probability. This implies that farmers under the PCMS were more economically efficient based on educational level.

Accounting for cropping system adopted, it can readily be seen that farmers under the PCM and FCM had an average economic efficiency level of 0.61 and 0.44 across the subset of those who adopted a mixed farming system respectively. The difference was significant at 1% level of probability. This implies that farmers under the PCM were economically efficiency that those under the FCM based on the cropping system.

Accounting for access to credit status, farmers under the PCM and FCM, with no access to credit, had an average economic efficiency level of 0.66 and 0.43 respectively. The difference was significant at 1% level of probability. Across the subset of those with access to credit, farmers under the PCM and FCM had an average economic efficiency level of 0.63 and 0.47 respectively. The difference was significant at 10% level of probability. The implication is that based on access to credit, farmers under the PCM were more economically efficient than those under the FCM.

4.4 Poverty Profile of Small Scale Farmers under PCM and FCM

The result of the poverty profile analysis of the small scale cassava farmers in Maigana zone is presented in Table 4.22. The income of a household reflects its ability to purchase its basic needs of life (Dontsop, 2011). Raising household income therefore has the ability to improve its standard of living and thereby reducing its poverty level. Based on the pooled data, 83% of cassava farm households were found to be living below the poverty line as the headcount was estimated to be 0.83 with a standard deviation of 0.03. Using 2/3 of mean per capita expenditure, Obisesan (2012) and Obisesan, Omonona, Yusuf, and Oni (2012) observed that over 50% of cassava farmers in South west Nigeria were poor. The poverty gap was 0.57, suggesting that cassava farm households, on average, had an income deficit of about 57% of the poverty line. In order words, about NGN 34, 425 are needed, on average, to take a poor farm household in the study area out of poverty irrespective of the cassava market participation system status. This poverty gap is less than that obtained by Tsue, Obekpa and Iorlamen (2013) who observed that 36.1% of the poverty line (NGN 41,680) was needed to take cassava farmers in Apa Local Government Area, Benue State, out of poverty. The poverty severity which represents the poorest among the poor farm households (Adekoya, 2014) was estimated to be 0.45. The implication is that poverty was equally severe among the respondents in the study area as about 67 cassava farm households out of 150 were found to be severely poor.

Table 4.22: Difference in poverty profile of small scale farmers under different cassava market participation in Maigana Zone, Kaduna State

	Market Participation				
Characteristics	**PCM (23)**	**FCM (123)**	**Difference**	**Total (150)**	**Test of Difference**
Poverty Incidence	0.96 (-0.04)	0.8 (-0.03)	0.16	0.83 (-0.03)	2.01**
Poverty Gap	0.49 (-0.05)	0.59 (-0.03)	-0.1	0.57 (-0.03)	-1.26
Poverty Severity	0.32 (-0.05)	0.48 (-0.03)	-0.16	0.45 (-0.03)	-2.13**

***P<0.05. T-test was used to examine the significance of the differences. Values in brackets are standard errors.*

Considering the analysis across cassava market participation system status, it was observed that, 96% of households under the PCM were below the poverty line as the headcount of this group of farmers was estimated to be 0.96. In the same token, the headcount of farm households under the FCM was 0.8; therefore suggesting that 80% of these households was poor. Consequently, on the basis of T-test, households under the FCM were found to be significantly less poor than those in the PCM in the study area during the 2013 farming season.

The poverty gap reflects the total deficit of all the poor households relative to the poverty line (Ravallion and Bidani, 1994). Referring to the poverty gap estimates, farm households under the PCM had a poverty gap of 0.49. The implication is that a household in this category, on average, needs about NGN 29, 592.86 to be pushed out of poverty. Farm Households under the FCM in the other hand need about NGN 35,632.22, to become nonpoor. The difference in poverty gap across both cassava market participation systems was not statistically significant.

The poverty severity of the farm households under PCM and FCM was estimated to be 0.32 and 0.48 respectively. The implication is that about 9 out of 27 cassava farmers under the PCM were severely poor while about 59 of out 123 cassava farmers under the FCM were severely poor in the study area during the period of study. The difference was significant at 5% level of probability implying that the severity of poverty was severe across farm households who participated in FCM.

4.5 Factors Affecting Poverty Status

Through maximization of the log likelihood function, estimates of the parameters of the logit regression model were obtained and presented in Table 4.23. It is worth pointing out that the logit regression model was not fitted for each of the defined categories of cassava market participation system due to the fact that the model was unable to run for the group of farmers under the PCM.

The chi-square statistic is significant at 1% level of probability. This implies that the joint effect of the regressors included in the model was significant in explaining the variation in the poverty status of the respondents. The Pseudo R^2 is 0.5 meaning 50% of the variation in the poverty status of the farm households was explained by the model. Individually, the strength of the influence of the predictors on poverty is better expressed in terms of odd ratio and marginal effect while the direction of the influence can be obtained directly from the sign of the coefficients which is represented by the first column in Table 4.23. Fourteen independent variables were included in the model out of which eight were found to be individually significant in terms of explaining the variation in poverty status. Land size, access to ICT, association membership, farm gate market, LGA status, and distance to market were insignificantly related to poverty. This implies that the variables were unimportant in predicting the poverty status of farm households in the study area. The following gives the detailed interpretation of the significant regressors.

Table 4.23: Maximum likelihood estimates of the logit model for the factors affecting the poverty status of the small scale cassava farmers in Maigana zone

Characteristics	Coefficients (Log Odds)	Odds ratio	Marginal effect	P-value	Mean (X)
Intercept Term	-4.87	0.76		0.14	NA
Age of household head	-0.27	1.2	-0.01	0.00***	37.17
Level of education	0.18	0.34	0.01	0.04**	6.68
Land size	-1.08	9.29	-0.03	0.2	NA
Improved cassava cuttings	2.23	8.49	0.09	0.01**	NA
Cropping system	2.14	1	0.04	0.03**	NA
Cassava output	0.0003	1.54	0.00001	0.00***	8848.91
ICT	0.43	3.78	0.01	0.34	4.98
Access to Credit	1.33	1.11	0.04	0.06*	NA
Association membership index	0.11	3.85	0.003	0.39	0.75
Extension service index	1.35	5.63	0.04	0.02**	1.28
Livestock ownership status	1.73	5.03	0.03	0.08*	NA
Farm gate market	1.61	0.87	0.1	0.29	NA
Distance to market	-0.14	2.3	-0.004	0.66	4.93
LGA	0.83	0.01	0.03	0.34	NA
Goodness of Fit					
Chi-square	67.49***				
Log Likelihood Function	-33.65				
Pseudo R2	0.5				
Number of observation	150				

****P<0.01, **P<0.05, *P<0.1 NA= Not available because the corresponding X variable is a dummy variable.*

Age of household head was significantly but negatively related to the logit (log odd) of becoming nonpoor irrespective of cassava market participation system status. The implication is that if the age of a household head increases by one year, the logit of a farm household to become nonpoor will decrease by 0.27. Using the odd ratio interpretation, it can be said that the chance for a household is, on average, 27 to 100 of becoming nonpoor if the age of household head increases by one year, *ceteris paribus*. Based on marginal effect, we can say that any additional year beyond the average age of about 37 years reduces, on average, will increase the probability of becoming nonpoor by 0.01, *ceteris paribus*. This is also to say that older farmers are less likely to become nonpoor than younger ones. It could be that young cassava farmers in the study area are more opened to the adoption of innovative practices and improved technology which is known in the literature to have a positive impact on welfare outcomes, in general. The finding is in line with the result of Tsue, Obekpa and Iorlamen (2013) who observed that age of household head was negatively related with poverty gap among cassava farmers in Apa Local Government Area, Benue State.

Level of education of household head was positively and significantly related at 5% level of probability to the logit of becoming nonpoor irrespective of cassava market participation system status. The implication is that any additional year of education, on average, increases the logit of becoming nonpoor by 0.18, *ceteris paribus*. In order words, for any additional year of education, the chance of becoming nonpoor is 34 to 100. The marginal effect of education level on poverty status suggests that, for any additional year of education beyond the average level of education of about 7 years, the probability of becoming nonpoor will significantly increase by 0.01, *ceteris paribus*. The result is consistent with the a priori expectation. This is due to the fact that education enlightens farmers with regards to farming activities and marketing efficiency. The finding is in line with the result of Obisesan (2012) who observed that the level of education of cassava farmers in South West of Nigeria significantly reduced their probability of becoming poor.

Improved cassava cuttings were positively and significantly related to the logit of becoming nonpoor irrespective of cassava market participation system status. The implication is that the adoption of improved cassava cuttings will increase the logit of becoming poor by 2.23, *ceteris paribus*. Based on odd ratio's interpretation, if a farm household adopts an improved variety of cassava cuttings, on average, the chance of becoming nonpoor is about 8 to 1, *ceteris paribus*. This is also to say that the marginal effect of adoption of improved cassava cuttings on the probability of becoming nonpoor is about 9%. This could be as a result of the fact that gains from new agricultural technology influenced the poor directly, by raising incomes of farm households, and indirectly, by raising employment and wage rates of functionally landless laborers, and by lowering the price of food staples (Irz *et al*., 2002; Evenson and Gollin, 2003; Bellon *et al*., 2006; Diagne *et. al*., 2009). A study by Adofu, Shaibu and Yakubu (2011) showed that adoption of improved cassava variety impacted positively on the productivity and revenue of cassava farmers in Kogi State. The finding is in conformity with work of Amao and Awoyemi (2008) who observed that adoption of improved cassava variety was negatively and significantly related to poverty gap Osogbo ADP Zone of Osun State. Adofu, Shaibu and Yakubu (2011) observed that the adoption of improved cassava variety improved the income of the adopters by about N27, 750 per farmer.

Cropping system was positively and significantly related to the logit of becoming nonpoor at 5% level of probability. The implication is that farm households that adopt a mixed cropping system will have an additional logit of 2.14 of becoming nonpoor than those who adopted a mono-cropping cropping system. In order words, switching from a mono-cropping system to a mixed cropping system will increase, on average, the probability of becoming nonpoor by 4%, *ceteris paribus*. The result is consistent with the a priori expectation. It could be that farmers employing mixed cropping system were engaged in the production of other high value enterprises. According to Gliessman (2014), through mixed cropping system, the dependence on one crop is avoided so that variability in prices, market, climate, and pests and diseases do not have drastic effects on local economics.

Cassava output was positively and significantly related to poverty status; this implies that by increasing cassava output by 100kg, the logit of becoming nonpoor will be increased by 0.03. In order words, the chance of becoming nonpoor is about 2 to 1, *ceteris paribus*. This is equivalent to say that, from the threshold of 8,848.91kg of output, any additional increase of 1kg of cassava output will increase the probability of a farm household of becoming nonpoor by 0.00001 irrespective of the cassava market participation system status. The finding is consistent with the a priori expectation.

Access to credit was positively and significantly associated to poverty status; this implies that having access to credit increases the logit of becoming nonpoor by 1.33. In other words, there is more than a 1 to 1 chance of becoming nonpoor for households having access to credit than their counterparts, *ceteris paribus*. Based to marginal effect, having access to credit will increase, on average, the probability of a farm household of becoming nonpoor by 4% irrespective of its cassava market participation system status. The finding is consistent with the a priori expectation. Nasiru (2010) noted that access to microcredit could have prospect in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities. The finding is consistent with the study of Obisesan (2012) who observed that access to credit was negatively related to the probability of becoming poor in Southwest of Nigeria.

Access to extension service was positively and significantly related to poverty status. The implication is that having access to extension service will have a marginal effect of about 4% on the probability to become nonpoor, *ceteris paribus*. The finding is consistent with the a priori expectation. It could be that farmers were able to enhance their productivity and income through the implementation of advice received from extension agents. The finding is consistent with the study of Nkonya *at al.* (2009) who observed that increase in the frequency of agricultural extension visits increased the propensity to escape from poverty and reduced stunting of children below five years old in Uganda.

Livestock ownership was positively and significantly associated to the logit of becoming nonpoor. The result reveals that livestock ownership increases the chance of becoming nonpoor. Specifically, there is a marginal effect of about 3% on the probability of becoming nonpoor for a household that owns livestock. This is probably because livestock ownership creates other source of income through the sale of live animals. Moreover, the asset (livestock) can be traded for food and therefore reduce the risk of food insecurity. Following Boughton *et al.* (2007), livestock income may also proxy for greater access to and incorporation of organic manure into plots, thereby increasing cassava productivity, marketable surplus and income through participation in market. The finding is in tandem with the study of Ali and Khan (2013) who observed that households having owned livestock have less poverty level in the range of 11-24 percent as compared to similar households having no livestock ownership in Pakistan.

4.6 Factors Affecting the Decision and the Level of Processed Cassava Market Participation

Efficient marketing system stimulates increased production, and the reverse constitutes a constraint to any development effort (Okereke, 1983). With the desire to provide solution towards creating a more conducive environment in the marketing chain for cassava, this section attempts to determine the factors that influence the level of participation in the processed cassava market system. The result of the analysis is presented in Table 4.24. It was obtained by running a Heckman two-step selection model using Stata 12 statistical program. The two-step option was considered because the maximum likelihood estimation of the parameters was taking time to converge. This could be as a result of the fact that farmers involved in the PCM were not many and thus less variability was present in the data. Moreover, as Heckman (1979) noted, two-step model is generally more stable when the data are problematic.

Table 4.24 shows the estimates of the parameters of the Heckman two-step selection model. The inverse of mills ratio (IMR) is significant at 5% level of probability. The implication is that sample selection (incidental truncation) is present in the decision process and therefore justifies the use of Heckman two-step selection model in place of separate models in predicting the decision and level of participation in PCM. The finding confirms our early suspicion that farm households were not randomly assigned to the PCM group. In order words, a straightforward comparison of farmers under the PCM and FCM based on welfare or other outcome of interest will provide a biased result of the true impact of participation in PCM. As explained in the methodology of this study, some variables present in the participation decision equation were voluntarily excluded from the participation level equation for consistency in the parameters' estimates. However, a variable like output was excluded from the participation level equation because of high collinearity with other factors. The estimated Wald statistic (2,677) is significant at 1% level of probability. The implication is that the model was significant in explaining the variation in the decision and level of participation in PCM. The explanatory power or goodness of fit of the specified variables as reflected by the Pseudo R^2 was not high enough; about 31% of variation in the decision and level of participation in PCM was explained by the model. The low coefficient of determination obtained is not surprising in cross-sectional analysis (Akinola, 1985).

4.6.1 Factors affecting processed cassava market participation decision

Thirteen factors were used to model the decision to participate in the processed cassava market system out of which only five were found to be statistically significant (Table 30). The insignificant factors are age of household head, marital status, education status, land size, quantity of seed, extension service, quantity of fertilizer and improved cassava cuttings. The implication is that all these factors were not important in explaining the variation in the decision to participate in the PCM. The significant factors are poverty status, cropping system, access to credit, community status and cassava output. A positive and negative signs indicate an increase and a decrease in the probability to participate in PCM respectively. The following gives a detailed discussion of the significant factors.

Cropping system is negatively and significantly related to the decision to participate in PCM; this implies that farmers who do not adopt mixed cropping system are more likely to participate in PCM than their counterparts. According to Bamidele, Babatunde and Rasheed (2008), cassava, when cultivated as a sole crop, results in higher outputs. It could be that farmers producing cassava as a sold crop are more expectant of greater harvest which will induce them more to participate in PCM.

Access to credit was positively and significantly related to the decision to participate in PCM; this implies that farmers with access to credit are more likely to participate to in PCM. This is consistent with the a priori expectation. According to Ouma, Jagwe, Obare and Abele (2012), credit acts as a production-enhancing input. These authors observed that access to credit was positively and significantly related to the decision to participate in banana market as a buyer among smallholder farmers in Central Africa. In their study credit acted as a consumption-enhancer.

Location status was positively and significantly related to the decision to participate in

PCM; this implies that farmers in Soba LGA are more likely to participate in PCM than those Kudan LGA. The average cassava output in Soba and Kudan LGAs was 10, 443.42kg and 7,648.33kg respectively. Moreover the distance to the nearest market was lower, on average, among farmers in Soba (4.13km) than among those in Kudan (5.53km). The positive and negative differential in output and transaction cost proxied by the distance to market respectively, is a possible explanation of the higher probability of farmers in Soba to participate more in PCM than their counterparts.

Cassava output was positively and significantly related to the decision to participate in PCM; the implication is that increase in output will increase the probability to of a farm household to participate in PCM, *ceteris paribus*. The result is consistent with the a priori expectation. Increase in output means possible availability of marketable surplus for processing and marketing. The finding is consistent with the study of Adenegan, Adepoju, and Nwauwa (2012) who observed that total maize produced was positively and significantly related to market participation among maize farmers in rural Osun State of Nigeria.

4.6.2 Factors affecting processed cassava market participation level

Seven factors were used to model the level of participate in the PCM out of which two were found to be significant (Table 4.24). The insignificant factors are age of household head, marital status, education status, quantity of seed and extension service. The implication is that all these factors were not important in explaining the variation in the level of participation in the PCM system. The significant factors are land size and the price of processed cassava output. A positive and negative signs indicate an increase and a decrease in the level of participation in PCM respectively. The following gives a detailed discussion of the significant factors.

Table 4.24: Maximum likelihood estimates of the Heckman two-step selection model for the factors affecting the level of market participation in the processed cassava market in Maigana zone.

	Participation Decision		Participation level	
Characteristics	**Coefficients**	**P -value**	**Coefficients**	**P -value**
Intercept term	-2.34	0.07*	-5633.83	0.69
Age	0.01	0.71	9.80	0.43
Marital status	0.03	0.98	2.99	0.96
Education Status	-0.09	0.78	8.71	0.7
Land size	-0.64	0.1	5.18	0.09*
Quantity of seed	0.001	0.21	1.25	0.91
Extension service	-0.12	0.65	10.02	0.61
Price of processed cassava			51.03	0.09*
Quantity of fertilizer	0.001	0.49		
Improved cassava cuttings	0.22	0.49		
Cropping system	-0.96	0.01**		
Access to credit	0.77	0.01**		
LGA	0.62	0.08*		
Cassava output	0.0001	0.08*		
Goodness of fit				
Inverse of Mills Ratio	-6272.99	0.03**		
Likelihood Ratio Test	42.94	0.00***		
Log Likelihood Function	-47.51			
Pseudo R^2	0.31			
Wald statistics	26.77	0.00***		

****P<0.01, **P<0.05, *P<0.1*

Land size was positively and significantly related to the level of participation in PCM; this implies that cassava farmers with more than one hectare of land are more likely to participate in PCM than their counterparts. The result is consistent with the a priori expectation as expected since land is a critical production asset having a direct bearing on production of surplus due to economies of scale (Tufa *et al.*, 2014). The finding is in conformity the work of Mukundi, Mathenge and Ngigi (2013) who observed that increased in total land owned among smallholder farmers in Southwest Kenya increased both the probability and level of participation in sweet potato market.

The price of processed cassava output is positively and significantly related to the level of participation in PCM; this implies that an increase in the price of processed cassava output will induce an average increase of about 51.03 kg of processed cassava output, *ceteris paribus*. This is consistent with the a priori expectation as increase in price creates incentives for market opportunities. The finding is consistent with the study of Boughton *et al.* (2007) who observed that the price of maize had a strongly and significantly positive effect on maize sales at the one percent level among rural households in Mozambique.

4.7 Impact of Processed Cassava Market Participation on Economic Efficiency Level

The model that permitted the estimation of the propensity score of participation in the processed cassava market is given in Table 4.25. The matrix of covariates on which the matching was done was composed of six characteristics. The model was significant at 1% level of probability. The goodness of fit as expressed by the Pseudo R^2 was low; only 16% of variation in the propensity score is explained by the model. However, it was not detrimental for the estimation of the impact of participation in PCM, since one of the most important conditions in nearest neighbor matching is the balancing property of the propensity score. The balancing property was satisfied and therefore households with the same propensity scores had the same distributions across all the six covariates over the four blocks automatically built during the estimation. In other words, the significance of the included variables is not important in the estimation of the impact as long as the balancing property is met which was indeed verified during the estimation.

Table 4.25: Maximum likelihood estimates of the propensity score of processed cassava market participation in Maigana zone

Characteristics	Coefficients	Std. Errors	P-value
Intercept term	-0.37	0.79	0.64
Age of household head	0.02	0.02	0.27
Marital status	-0.49	0.73	0.50
Cropping system	-1.15	0.28	0.00***
Improved variety	0.23	0.27	0.40
Land size	-0.02	0.28	0.95
Farm gate status	0.23	0.62	0.71
Goodness of fit			
Likelihood ratio test	22.54		0.00***
Pseudo R^2	0.16		
Log likelihood function	-59.44		
Number of observation	150		

*** *P<0.01*

Table 4.26 shows the maximum likelihood estimate of the Tobit regression model of economic efficiency level for cassava production. The Chi-square statistic was significant at 10% level of probability. The implication is that the joint effect of the regressors in the model on economic efficiency is significantly different from zero. In order words, the model was significant in explaining the variation in the economic efficiency levels of cassava farmers in the study area. The pseudo R^2 which represents the goodness of fit was 0.42; this implies that 42% of variation in the economic efficiency levels of cassava farmers was explained by the model. The interaction term was positively and significantly related to the level of economic efficiency; this attests that sample selection was indeed present and that the impact is not homogeneous (Glele, Adekambi, Agli, Tamegnon, and Adegbola, 2008). It equally means that the specification of the impact model was correct.

The impact of participation in PCM on economic efficiency was positive but insignificant. This could mean that, although market increase efficiency through specialization and use of improved technology, the influence was weak and indirect.

Another possible explanation of the insignificance is that technically, participation in PCM is endogenous, that is, participation in PCM is also a function of some observable and possibly unobservable factors affecting economic efficiency level. Thus, the strong expected relationship between participation in PCM and the regressors included in the model could be the reason of the insignificant impact of participation in PCM on economic efficiency level since the standard error could be larger than it should. However, following (Zanutto, 2006), the significance of the interaction between the treatment variable and the covariates confounded in the propensity score can be interpreted as the impact of participation in PCM on economic efficiency level when participation in PCM is interacted with the covariates considered in the propensity score.

Table 4.26: Maximum likelihood estimates of the Kitchen Sink Tobit regression model for the impact of processed cassava market participation system on economic efficiency level of small scale cassava farmers in Maigana zone

Factors	Coefficients	Std. Errors	T-statistics
Intercept term	0.49	0.03	14.81***
Participation	0.05	0.07	0.71
$pscore$	-0.15	0.17	-0.92
Participation*$(pscore - \overline{pscore})$	0.59	0.33	1.79*
Goodness of fit			
Chi-square test statistic	6.46		0.09*
Pseudo R^2	0.42		
Log likelihood function	-4.37		
Number of observation	150.00		

**** P<0.01, *P<0.1*

Hypothesis 1: there is no significant impact of cassava market participation on economic level. The result of the test is presented in Table 4.27. The test was insignificant and hypothesis 4 was therefore accepted. This implies that processed cassava market participation did not significantly enhance the economic efficiency level of the participants.

Table 4.27: Impact of cassava market participation on economic efficiency level

Hypotheses	**Test-statistic**	**Test-statistic value**	**Decision**
There is no significant impact of cassava market participation on economic efficiency level	T-test	0.71***	Accepted

****P<0.01*

4.8 Impact of Processed Cassava Market Participation on Poverty Level

The impact of PCM on poverty proxy by the per capita income of farm household is given in Table 4.28. The estimation was performed using Stata 12. The 27 treated cases (those who participated in PCM), were only able to be matched with 22 farm households who were then regarded statistically as the control group. After the matching, the difference in weighted per capita income of the treated and the control was estimated to be NGN 12, 163.83. The difference represents the impact of participation in PCM on poverty level. In other words, participation in PCM increases the per capita income by NGN 12, 163.83. It is equivalent to say that participation in processed cassava market system reduces, on average, the per capita income deficit by NGN 12, 163.83.

Table 4.28: Impact of participation in processed cassava market system on poverty level of small scale cassava farmers in Maigana zone

Number of treated	**Number of control**	***ATT* (NGN)**	**Std. Error**	**T-Statistic**
22	22	12,163.83	6, 680.08	1.82*

**P<0.1. ATT (Average Treatment Effect on the Treated) was estimated using Stata version 12.*

Hypothesis 2: There is no significant impact of cassava market participation on poverty level. The result of the test is presented in Table 4.29. The test was significant at 10%

level of probability and hypothesis 5 was therefore rejected. This implies that processed cassava market participation significantly enhance the income of the participants and therefore reduced their poverty level.

Table 4.29: Impact of cassava market participation on poverty level

Hypotheses	**Test-statistics**	**Test-statistics value**	**Decision**
There is no significant impact of participation in processed cassava market system on poverty level.	T-test	1.82*	Rejected

**P<0.01*

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

Two Local Government Areas were considered for the study namely Soba and Kudan from which three villages were randomly selected from each of the LGAs using simple random sampling technique. The broad objective of the study was to estimate the impact of cassava market participation on farmers' economic efficiency and poverty level in Maigana agricultural zone, Kaduna state while the specific objectives were to describe the socioeconomic characteristics, examine the profitability to cassava production, examine the economic efficiency level, examine the poverty profile, determine the factors affecting poverty status and to determine the factors affecting cassava market participation of farmers in the study area.

Primary data were exclusively used for the study and were gathered from 150 cassava farmers using structured questionnaires. The statistical tools used to conduct the analysis were descriptive statistics, gross margin method, stochastic frontier translog and Cobb-Douglas cost and production functions respectively, Foster Greer and Thorbecke poverty decomposition model, logit regression model, Heckman two-step selection model, Kitchen sink Tobit regression model, Propensity Score Matching (*PMS*) estimators and various tests such as Likelihood ratio (LR) test, Wald test, Chi-square test, F-test and T-test.

A descriptive statistics analysis was done in order to understand the composition of the sampled farm households based on their socio-economic characteristics. The result revealed that only one female farmer was involved in the production of cassava during the farming season and that the proportion of farmers across the processed and fresh cassava market participation based on gender was not significant. This observation was also true based on the number of years of education and the age of the household heads as averagely no significant difference was observed across the groups of cassava market participation. However, it was discovered that the level of literacy was quiet important in the pooled sample in general as only less than 1% of farmers did not have any formal level of education. Irrespective of the type of cassava market participation status, household heads were relatively young with an average of 37 years.

The majority of farm households used less than or equal to 1 ha of land for cassava production without any significant difference in the proportion of farmers in this category based on market participation status. Sole cropping system dominated other forms of cropping system among the farmers. 57.05 % of the farmers were from Soba while 42.95 % were from Kudan. It was also discovered that farmers under the processed cassava market participation significantly had less contact with extension agent but more with farmers' association than their counterparts and with equal exposition to information. Finally, farmers under the processed cassava market participation had more fresh cassava output and yield than their counterparts. The difference in cassava output and yield of 4028.93 kg and 3,190.7 kg/ha were significant at 1 and 5% level of probability respectively.

It has been argued that market-oriented production can achieve welfare gains through comparative advantage, economies of scale and regular interaction and exchange of ideas (Mathenge, 2010). This study set out to assess the impact of cassava market participation on farmers' economic efficiency and poverty level in Maigana Agricultural zone, Kaduna State. Using a sample of 150 small scale cassava farmers across Soba and Kudan LGAs via a multi-stage sampling technique, the study revealed that cassava production is profitable in the study area with households who participated in processed and fresh cassava market making, on average, ₦3.33 and ₦ 1.98 per naira per hectare of land respectively.

Given the non-experimental nature of the data, methods based on propensity sores were adopted in order to assess the impact of cassava (processed) market participation on economic efficiency and poverty level. The study showed a positive but insignificant impact of processed cassava market participation on economic efficiency level. However, participants in PCM were found to have higher economic efficiency level than their counterparts. On the other hand, the impact of processed cassava market participation on poverty level was significant. Specifically, the result suggests that processed cassava market participation raises per capita income by NGN 12, 163.83 which is about NGN 158, 129.79 annually for a household. Poverty incidence although prevalent among the participants in PCM was less severe than among their counterparts. The study further showed that key factors such as the level of education of the household head, improved seed variety, access to extension service and livestock ownership increased the likelihood of becoming non-poor among the sampled households.

The findings equally revealed that some socioeconomic characteristics of farmers such sole cropping system of farming, access to credit and the quantity of cassava output are important in terms increasing the probability to participate in processed cassava market in the study area. For the enhancement of level of processed cassava market participation factors such as land size and the price of processed cassava output were observed to be significant.

5.2 Conclusion

On the basis of the findings of this study, it can be concluded that farmers who participated in processed cassava market performed better in terms of achieving the maximum possible of output given the resources employed and the technology available, but in terms of allocating inputs no significant difference was observed. Combining technical and allocative efficiencies into economic efficiency, the result permitted us to find that farmers who participated in processed cassava market have more ability to maximize their output at minimum costs than their counterpart.

Cassava production was found to be profitable in the pooled data and across market participation status. However, farmers who participated in processed cassava market realized, on average, a significant increase of NGN 1.35 more than their counterparts. Moreover, it was discovered that participating in the processed cassava market increased the per capita income of the participants by NGN 12, 163.83 and therefore reducing the poverty gap between the poor and the nonpoor farmers. However, its impact on the levels of economic efficiency, although positive, was not significant. Based on the finding, it can be concluded that processing cassava before selling is more significant in terms of reducing poverty than selling it fresh in the study area.

The study has empirically evaluated a number of factors hypothesized as important determinants of participation in processed cassava market. It thus confirmed the dependency between the discrete decision to participate in processed cassava market and the intensity of the processed tuber sold. Individual-level factors did not come out as significant determinants of the level of market participation conditional on the probability of participation. A result which was equally observed by Siziba *et al.*, (2010) Farm-level factors on the order hand was the only group of factors that influence the level of participation in the processed cassava market such as other forms of cropping system than mono-cropping system and land size beyond 1 ha were found to be significant. In terms of predicting poverty, livestock ownership a proxy to private asset, cassava output, level of education beyond primary level, access to credit and contact with extension agents are all important.

In general the findings of the study lend support to the advocacy for policies that encourage investment in public infrastructure and agricultural services such as research and extension training as these variables were highly and positively related to either the decision or the quantity of processed cassava sold by the small scale farmers in the study area.

5.3 Recommendations

From the findings of the study, the following recommendations, among others are put forward:

1. Cassava framers in the study area should devote more land to cassava production.

2. Extension agents should encourage farmers to participate more in processed cassava market through dissemination of improved cassava cuttings variety and more information about the various cassava processing activities and their related advantages in the study area as well as providing basic training in cassava processing.

3. Agricultural credit facilities should be made more accessible to cassava farmers to

stimulate more investments in cassava processing activities perhaps through reduction of interest rates.

4. Cassava farmers should increase their levels of agricultural risk copping strategy through more involvement in livestock keeping and use of other forms of agricultural cropping system than the mono-cropping system.

5. Government and development agencies should introduced improved cassava processing technologies to stimulate more participation in processed cassava market.

5.4 Contribution of the Study to Knowledge

1. The study revealed that cassava production in the study area is profitable with a net farm income of NGN 94, 297.47.

2. The study revealed that farm households who participated in the processed cassava market realized NGN 3.33 per naira invested, while those who participated in the fresh cassava market realized NGN 1.98 per naira invested.

3. The study revealed that cassava farmers under the processed cassava market participation system, on average, can still improved their current level of output by 22%, while their counterpart can still increase theirs by 54%.

4. The study revealed that farm households who participated in processed cassava market are 20% more economically efficient than their counterparts.

5. The study revealed that poverty incidence is more pronounced among households that participated in the processed cassava market, but that poverty gap and poverty severity are more pronounced among those who participated in the fresh cassava market.

6. The result revealed that individual, institutional, private asset (livestock), and farm-level factors increase the probability of becoming nonpoor among small scale cassava farmers in the study area.

7. The study revealed that participation in the processed cassava market, on average, reduced the poverty gap of the farm households under the processed cassava market participation system by NGN 12, 163.83.

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Appendix

Questionnaire

Section 1: Identification information

Name of farmer (optional):
Tel. No. (optional):

Section 2: General information

State:	**Date of interview:**
LGA:	**Name of interviewer:**
Village:	**Name of supervisor**

Section 3: Socioeconomics Characteristics

Characteristics	**Codes**	**Answer**
1. Sex:	1= male, 2= female	
2. Age	Age in completed years	
3. Marital status	1= single, 2= married, 3= separated, 4= divorced, 5= widowed	
4. Family Size	No. of persons living with you and sharing your meals daily	
5. Level of education	Number of years of education	
6. Main activity	1= crop farming, 2= livestock rearing, 3= house chores, 4= commerce, 5= laborer, 6= civil servant, 7= others (specify)	
7. Secondary activity	1= crop farming,	

<table>
<tr><td></td><td colspan="3">2= livestock rearing,
3= house chores,
4= commerce,
5= laborer,
6= civil servant,
7= others (specify)</td><td></td></tr>
<tr><td>8. How long have you been in cassava farming?</td><td colspan="3">Years of experience</td><td></td></tr>
<tr><td rowspan="4">9. What was the size of land use for cassava production last year and the amount spent to rent it last year?</td><td>Plot</td><td>Size</td><td>Unit</td><td>Amount (₦)</td></tr>
<tr><td>Plot</td><td></td><td></td><td></td></tr>
<tr><td>Plot</td><td></td><td></td><td></td></tr>
<tr><td>Plot</td><td></td><td></td><td></td></tr>
<tr><td>10. What was the main source of land used last year for cassava production?</td><td colspan="3">1= Inherited
2= Bought
3= Rented
4= Gift
5=Other (pls. specify):</td><td></td></tr>
<tr><td>11. Did you use credit last year?</td><td colspan="3">1= Yes,
2= No</td><td></td></tr>
<tr><td rowspan="7">12. If yes, what was the amount of credit used last year?</td><td colspan="3">Source</td><td>Amount (₦)</td></tr>
<tr><td colspan="3">1= Commercial Bank</td><td></td></tr>
<tr><td colspan="3">2= Bank of Agriculture</td><td></td></tr>
<tr><td colspan="3">3= Cooperative Societies</td><td></td></tr>
<tr><td colspan="3">4= Money Lenders</td><td></td></tr>
<tr><td colspan="3">5= Friends And Family</td><td></td></tr>
<tr><td colspan="3">6= Others (Specify)</td><td></td></tr>
<tr><td>13. Did you invest part of the credit received in</td><td colspan="3">1= Yes, 2= No</td><td></td></tr>
</table>

cassava production?		
14. Have you been visited by an extension agent since you started farming?	1= Yes, 2= No	
15. If Yes, How many times?		
16. How many times were you visited last year?		
17. In which of the following categories the training has been based on last year?	1= Production 2= Processing 3= Marketing	
18. What about the previous years?	1= Production 2= Processing 3= Marketing	
19. Do you belong to any association?	1=Yes 2= No	
20. Do you discuss issues related to crop farming in that/those association(s)?	1=Yes 2=No	
21. For how long have you been In that/those association(s)? (years)		
22. What cropping system did you adopt for cassava production last year?	1= Mono cropping 2= Mixed cropping 3= Intercropping 4= others (Specify)	
23. Do you have mobile phone?	1=Yes 2=No	
24. Do you have radio?	1=Yes	

	2=No	
25. Do you have television?	1=Yes 2=No	
26. Livestock ownership	1=Yes 2=No	
27. Do you use any of the above devise to acquire knowledge about crop production?	1=Yes 2=No	

Section 4: On-farm and off-farm income (*Provide estimation*)

Source	**Codes**	**Amount (₦)**
1. Cassava income	Value of cassava sold (processed and unprocessed)	
2. Income derived from other produce	1= Maize (processed and/or unprocessed)	
	2= Cowpea (processed and/or unprocessed)	
	3= Rice (processed and/or unprocessed)	
	4= Vegetable (processed and/or unprocessed)	
	5= Yam (processed and/or unprocessed)	
	6= Millet (processed and/or unprocessed)	
	7= Sweet potato (processed and/or unprocessed)	
	8=Others (Specify) (processed and/or unprocessed)	

Section 5: Inputs Used for cassava production last year?

a. Land size

Plot No	**Size**	**Unit**	**Amount spent for renting**
1			
2			
3			

c. Seed acquisition

Plot No	Seed type Used	Quantity	Unit of measurement	Cost transportation (₦)	Value of quantity purchased (₦)
1					
2					
3					

d. Fertilizer acquisition

Plot No	type used	Quantity	Unit of measurement	Cost transport (₦)	Value of quantity purchased (₦)
1					
2					
3					

e. Herbicide acquisition

Plot No	type used	Quantity	Unit of measurement	Cost transportat (₦)	Value of quantity purchased (₦)
1					
2					
3					

f. Pesticide acquisition

Plot No	type used	Quantity	Unit of measurement	Cost transportation (₦)	Value of quantity purchased (₦)
1					
2					
3					

g. Labour input

1. Land preparation

Plot No	Hired Labour			Family Labour		
	No of people	Man-day	Cost (₦)	No of people	Man-day	Cost (₦)
1						
2						
3						

2. Planting

Plot No	Hired Labour			Family Labour		
	No of people	**Man-day**	**Cost (₦)**	**No of people**	**Man-day**	**Cost (₦)**
1						
2						
3						

3. Fertilizer Application

Plot No	**Hired Labour**			**Family Labour**		
	No of people	**Man-day**	**Cost (₦)**	**No of people**	**Man-day**	**Cost (₦)**
1						
2						
3						

4. First Weeding

Plot No	**Hired Labour**			**Family Labour**		
	No of people	**Man-day**	**Cost (₦)**	**No of people**	**Man-day**	**Cost(₦)**
1						
2						
3						

5. Second Weeding

Plot No	**Hired Labour**			**Family Labour**		
	No of people	**Man-day**	**Cost(₦)**	**No of people**	**Man-day**	**Cost (₦)**
1						
2						
3						

6. Harvesting

Plot No	**Hired Labour**			**Family Labour**		
	No of people	**Man-day**	**Cost (₦)**	**No of people**	**Man-day**	**Cost (₦)**
1						
2						
3						

Characteristics	**Codes**				**Answer**
1. When did you harvest your cassava crop last year?	Month:				
2. What quantity in	**Plot**	**Type**	**Quantity**	**Unit**	

total did you harvest last year? (Pls. specify the type, quantity and unit)	Plot1				
	Plot2				
	Plot3				
3. Is there a market in your area/village where you can sell your cassava produce?	1= yes, 2= No				
4. Did you sell any fresh cassava root last year?	1= yes, 2= No				
5. When did you sell the fresh cassava root last year?	Month:				
6. Where did you sell your fresh cassava root last year?	1= Farm gate 2= Village market 3= out of the village 4= others				
7. What is the distance from your farm to the market where you sold your fresh produce? (estimate in *km*)					
8. If yes, what was your major mean of transportation to get your output (processed/unprocessed to the market?	1= foot 2= bicycle 3= motorbike 4= car 5= others				
9. What quantity of fresh cassava did you sell last year? (Specify the value of the quantity sold)	**Plot**	**Type**	**Quantity**	**Unit**	**Value (₦)**
	Plot1				
	Plot2				
	Plot3				
10. What was the total cost of transportation associated with the sale of your fresh cassava produce?					
11. Did you process any cassava harvested from your farm last year?	1= yes, 2= No				
12. Did you sell any quantity of the processed cassava last year?	1= yes, 2= No				

13. If yes, what quantity of processed cassava did you sell last year? (Specify the value of the quantity sold)	**Plot**	**Quantity**	**Unit**	**Value (₦)**
	Plot1			
	Plot2			
	Plot3			

Section 7: Perception and indicators of poverty by farmers

Questions	**Codes**	**Answer**
1. For how long have you been in this village/community?		
1. Do you know when somebody is being poor?	1=Yes 2=No	
2. Do you think there are people in this village/community who are poor?	1=Yes 2=No	
3. In your opinion, what is the change in their poverty status over some couple of years?	1=decreasing 2=increasing 3=about the same 4=don't know	
How much a day do you think are necessary to keep a house such as the one you live in, out of poverty? (₦)		
Do your house above that level or below?	1=Above 2=Below	
How far above or below would you say your household is?	1= A lot above that income 2= A little above 3= a little below 4= A lot below 5=Don't know	
What, in your opinion, are the main reasons why these people are poor? (*In order of importance*)		
a) b) c) d) e)		