PROFIT EFFICIENCY OF CASSAVA PRODUCTION IN EASTERN AND BRONG AHAFO REGIONS OF GHANA

BY

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A THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS, COLLEGE OF BASIC AND APPLIED SCIENCES UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN AGRIBUSINESS

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DECLARATION

I, **BILSON KOFI KUDIVO**, the author of this thesis, do hereby declare that except for the references which have been duly cited, the work presented in this dissertation, ***"PROFIT EFFICIENCY OF CASSAVA PRODUCTION IN EASTERN AND BRONG AHAFO REGIONS OF GHANA"*** was done entirely by me in the Department of Agricultural Economics and Agribusiness, College of Basic and Applied Sciences, University of Ghana, Legon, from September 2017 to May 2018. This work has never been presented either in whole or in part for any other degree of this University or elsewhere.

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DEDICATION

I dedicate this thesis to my mother Juliette Esi Tamaklo, Boadiwa -Yirenkyi Millicent and Madam Diana Aku Mensah.

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ABSTRACT

The primary objective of this thesis is to assess the profit efficiency of cassava production in the Eastern and Brong Ahafo regions of Ghana. The study used farm level data to estimate the cost and return levels of farmers, profit efficiency and its determinants, and ranked major constraints facing the farmers. A multi-stage sampling technique was used to collect cross-sectional data from 300 cassava farmers in four districts in the two regions during the period of 2017 to 2018 production year. The Net Farm Income (NFI), Return on Investment (ROI) and profit efficiency were estimated for the farmers, the stochastic frontier profit function and farm specific inefficiency models were estimated using the FRONTIER 4.1 while the Kendall's Coefficient of Concordance was used to the rank famers' constraints. A Net Farm Income (NFI) value of GHS 4457.24 with a profit margin of 75% was realized for farmers in the study area. About 12% returns are made on the farmer's capital investment. Results from the t-test showed that even though cost in the two regions differ, profits are not significantly different. Result from the frontier estimation indicates that elasticities of mean output for agrochemicals and planting materials were significant in influencing the profit of farmers. The result further shows that on the average, the cassava farmers are 86.4% profit efficient, revealing that cassava producers on average are not operating on the profit frontier. This means that cassava farmers lose 13.6% of their profits as a result of inefficiency on their part. The results further indicate that educational status of farmer, membership of farmers-based organization, age of farmer, experience, gender, and marital status of the famer are the main factors that significantly explain the variation in famers' profit inefficiency. Lack of land for cultivation, inadequate working capital, poor market price and lack of improve planting materials are the major constraints to cassava production identified in the study area. It is therefore concluded that cassava production in the study area is very profitable though farmers not able to accrued all the associated profit due inefficiency arising from their input mix. Inadequate capital, lack of farmland, poor pricing and lack of improve planting materials are the major constraints militating against the success of cassava production in the study area. The study recommend that Government should intensify the requisite supports, policy interventions given to cassava production. This can be done by providing incentive packages for the youth who are interested in venturing into cassava production, either through the supply of inputs or initial startup capital for cassava production. Improved and high yielding cassava variety with minimum pricing should be developed by relevant research institutes and made available to farmers so as to raise the current yield of cassava per unit land area and increase the farmers' profit. Government should introduce policies and interventions that would improve access to productive inputs (land), machinery (tractor service), infrastructure (road network) and marketing facilities should also be pursued by the government to enhance the competitiveness of cassava production and increase profit efficiency of cassava production.

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LIST OF ABBREVIATIONS AND ACRONYMS

CRS	Constant returns to scale
CSIR	Council for Scientific and Industrial Research
DEA	Data Envelopment Analysis
DFA	Distribution-Free Approach
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistics
FASDEP	Food & Agriculture Sector Development Project
FRI	Food Research Institute
GDP	Gross Domestic Product
GHS	Ghana Cedis
GSS	Ghana Statistical Service
GLSS	Ghana Living Standard Survey
HQCF	High-Quality Cassava Flour
METASIP	Medium Term Agriculture Sector Investment Plan
MoFA	Ministry of Agriculture
MT	Metric Tonnes
NPACI	NEPAD's Pan African Cassava Initiative
PSI	Presidential Special Initiative
SFA	Stochastic Frontier Approach
SRID	Statistics, Research and Information Directorate
VRS	Variable Returns to Scale

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Agricultural production and efficiency continue to be the center of major debates, policies and strategies that link with the agricultural sector. Under the Sustainable Development Goals, relevance is given to agricultural productivity which underscores the myriad reasons for supplementary research on statistical frameworks for productivity and efficacy which is important and targeted to developing countries. (FAO, 2017). Productivity and Efficiency Measurement in Agriculture).

Several countries including Ghana have developed productivity-improving agricultural policies and strategies, particularly, as agriculture forms a major backbone of the country`s economy, and the gap in productivity between the primary and secondary sectors is widespread. Augmenting agriculture production in the country is important because of its role as a poverty reduction or pro-poor development tool which enhanced food security and higher farm incomes.

In the farm enterprise business, efficiency is directly related to making a profit. Nonetheless, without profit, the farm enterprise will go bankrupt. Efficiency is built into the culture of every private organization if not, the organization will quickly cease to exist. Apparently, farmers that are turnover efficient, are those that pay the least revenue to owners of production inputs eg. Agrochemical, land, labor etc. (Ettah & Nweze, 2016).

Basically, profit efficiency concept is useful in evaluating if an input is disbursing an optimal well-adjusted level of rent payment for the utilization of such capital. It is a measure of the economic performance of a farm (Adesina & Djato, 1997). Production inputs that deliver inadequate proceeds are said to be profit inefficient. It is better that inputs of such nature be reinvested in alternative income-generating options to farmers where the perceived returns are higher.

Ghana like other non-industrial nations in West Africa is fundamentally an agrarian. Agriculture contributes to 54 % of Ghana's GDP and accounts for over 40% of export earnings, while at the same time providing over 90% of the food needs of the country. Ghana's agriculture sector is predominantly engaged in the production of either crop, domesticated animals, fishing or in preparing and promoting of agrarian produce (MoFA, 2016) on a formalized and casual premise. Farming in Ghana is mostly done by smallholder farmers and is traditionally rain-fed (SRID,2001). The sector is a significant supporter of Ghana's unfamiliar trade income. The fare of non-conventional agrarian wares expanded from GH¢ 962 million in 2014 to GH¢ 1,901 million in 2016 (MoFA, 2017)

Cultivation of crops such as maize, yam, cowpea, rice, cassava, and others in Ghana is predominantly on the smallholder scale. Majority of farms are less than 2 hectares (MoFA, 2016). However, there exist some huge tracts of farms predominantly for oil palm, rubber and coconut and to a lesser degree, pineapple, rice, cassava and maize. The principal farming scheme is customary which employs hoe and cutlass for farm practices. About 52% of the labour force and 85% of rural households are engaged in agriculture and approximately 39% of whom are women (GSS 6, 2014). Cassava cultivation area in Ghana expanded from 3.0 % in 2016 to 8.4 % in 2017 while its commitment to GDP within the period fell from 18.7 percent to 18.3 percent in both years respectively. Ghana's export earning is mainly from agriculture, and cocoa remains the principal export product. Ghana's agricultural sector though in need of more boosts, has been over the years remained the dominant source of raw material for local industries and major producer for both rural and urban population.

The government of Ghana is poised on increasing production of non-traditional products such as cassava, expanding processing capacity, attracting private investment and creating jobs through agribusiness development. A total cost of approximately GH₵9.543 Billion (excluding the cocoa sub-sector strategy), is budgeted for in the Planting for Food and Jobs Programme, to enable above 500,000 producers to improve food production as well as generate employment for the youth in agribusiness (*Bua*, *et al*, 2020; MoFA, 2018).

Cassava (*Manihot esculenta*) as a crop is of great importance in Sub-Saharan Africa, which helps as a key source of income. Cassava also develops much better on soils deemed marginal than crops that have need of greater soil fertility (NISER 2001, Hillocks, 2002). It is a drought-tolerant crop and can produce reasonable yield where many other crops do not thrive well. Principally, cassava is cultivated because its tuberous root and leaves, are used as delicacies, animal feed and industrial usage such as pharmaceuticals purposes (FAO, 2009). The value of cassava nutrition is enormous. The water content of cassava is approximately 60%, and it is also rich in vitamins, carbohydrates and calcium but low in proteins and lipids (Yakassai, 2010). Cassava products when eaten together with protein and other food supplements such as beans and oil enhanced energy production (FAO, 2009). Presently, Ghana government and other stakeholders have implemented programmes to increase cassava cultivation in the country. Root and Tuber Improvement & Marketing Programme (RTIMP) rolled out interventions between 2007 and 2014 led to an upsurge in the harvests in cassava nationwide, thus bringing about a call for replication of high yielding varieties across the board for farmers (FAO, 2009). Additionally, the West Africa Agricultural Productivity Programme (WAAPP) facilitated the introduction of novel cassava assortments to farmers. These interventions, including cassava value addition, increased household production of cassava and reduced post-harvest losses. In Ghana, cassava cultivators are within the lowest rank with regard to the hierarchy of farming. Practically, it is obvious that when cassava production is modernized, household income would experience increment (MOFA. 2006). Subsequently, in the bigger plan of raising livelihoods, the government presented the Presidential Special Initiative (PSI) during the mid-2000s. As a feature of the PSI-Cassava Programme, a manufacturing plant was built in a cassava producing enclave in the Central Region to produce starch for foreign trade (Sam, 2001).

Generally speaking, by 2020, global demand for cassava is expected to reach the level of 275 million tons (Westby, 2008) even though its production in Africa lies around 62 per cent of the overall global output where Nigeria produces the largest amount to the global total with a yield level of 60 million tons in 2019 (FAOSTAT, 2019).

Ghana is ranked the 6th largest producer of cassava globally (with an estimated output of 18,470,762 metric tonnes) and 3rd in Africa (FAOSTAT, 2017). An estimated 70 percent of local farmers cultivate cassava, turning out more than 18 million metric tons every year (Laary, 2015).

Domestically, cassava has conventionally been used up as fresh cassava roots and processed items, for example, *Gari*, *Kokonte*, *Agbelema* amongst others (SRID, 2013-2014). Through the most recent five years, cassava production has seen consistent progress in need for commercial and domestic industrialized utilization due to the modern value addition to cassava products, especially Industrial Grade Cassava Flour, High-Quality Cassava Flour, High-Quality Cassava Chips, Wet Cake, Bio-Ethanol and Starch (MoFA, 2013).

In Ghana, cassava industrialization and commercialization have the potential to revamp the country's economy, especially, when the right variety is planted and harvested under acceptable practices. The present phenomenon in cassava production and processing creates an additional opportunity for the supply chain actors to influence the income and prosperity of farmers. The major cassava production intervention initiated to increase productivity is the presidential initiative and transformation agenda, have been implemented on cassava by Ghana government in 2001 which has practically no effect on industrial utilization, competitiveness and export. Ghana's export portion of the cassava worldwide market has stayed low notwithstanding the implementation of the intercessions. Production cost in processing factories remained exorbitant. High production cost has been aggravated by high transportation arising from the poor condition of road to the farms of smallholder farmers and high cost of alternative source of energy (generating plant) arising from an epileptic power supply in the country. Poor road infrastructure and transportation has hindered linkage of smallholders to emerging market despite Ghana being the sixth producer of cassava in the world with expanding area under cultivation of the crop.

In 2010, CSIR-CRI developed four cassava varieties namely, Ampong, Buroni-Bankye, Sika Bankye and Otuhia. These new varieties are superior to the existing varieties such as Afisiafi, Dokuduade, Essambankye, Agbelifia and Bankyehemaa in terms of yield, dry matter, resistance to African Cassava Mosaic Disease (CMD) and adaptability to wider ecological environments (MOFA 2016). The varieties form wider canopies at early stages of development and compete favourably with weeds thus reducing labor input and costs for farmers. Ghana has four major types of cassava varieties developed by the CSIR for planting (MOFA 2013). See Table 1.1 for the varieties of cassava planted in Ghana.

Table 1. 1: Cassava Varieties in Ghana

Varieties	*Mean Root Yield(T/h)*	*Maturity period (period)*	*Total dry matter (%)*	*Uses*	*CMD Resistance*	*Suitable Ecologies*
AMPONG	12	59	36	Flour, starch, poundable	Resistant	Forest, Transition and Savannah
BURONI BANKYI	16	40	33	Flour and bakery products	Resistant	Forest, Transition and Savannah
SIKA BANKYE	18	56	36	Hi- starch	Tolerant	Forest, Transition and Savannah
OTUHIA	12	65	39	Starch and flour	Resistant	Forest, Transition and Savannah

Source: MoFA, 2013

1.2 Problem Statement

The total amount of cassava available for human consumption in Ghana is 17,212,698MT with a surplus of 7,68`1,606MT which in most cases remained unharvested or gets rotten on the farms (MoFA, 2015/2016). Greater number of people living in the tropics and sub-humid tropical regions of Africa consider cassava as a nutritional food for energy. (Tsegi *et al*., 2002). In Ghana, the demand for cassava for industrial use is high while its commercialization has vast potential.

In spite of the volume of cassava production in Ghana, the nation imports critical amounts of cassava items, for example, starch, flour, sweeteners that can be derived from cassava for industrial use (FAOSTAT, 2015). The largest opportunity for cassava industrialization in Ghana is for ethanol production which is used by domestic industries. This is followed by food-grade starch and High-Quality Cassava Flour (HQCF) for export to regional markets and domestic markets respectively. Approximately, 66,000MT of cassava is processed industrially in Ghana (FAOSTAT, 2015). In the international market, there is a high demand for cassava chips for the production of animal feed and the pharmaceutical industries.

By end of the year 2020, it is estimated that the total demand for cassava for industrial use will increase to 16 million MT per year indicating both domestic demand from Ghanaian industries and regional demand from other ECOWAS markets (FAOSTAT, 2015). Nevertheless, ninety percent (90%) of cassava produced in Ghana by smallholder farmers undergoes basic processing and is consumed as traditional foods. Apparently, farmers in Ghana are yet to attain the desired cassava production efficiency levels, due to lack of inputs notably fertilizers, weedicides, high yielding cassava assortments, policy intervention and improved technology, a situation where farmers still practice the orthodox methods of cultivating cassava which inhibit productivity hence low returns (Ezedinma *et al*., 2006).

Presently, the average cassava yield is about 16 metric tons per hectare compared to an estimated 28 metric tons per hectare. Farmers' productivity is low due to insufficient incentives for increased yield. The Food & Agriculture Sector Development Project (FASDEP) II focuses on the improvement of the cassava sub-sector and the intensification of industrial processing to bolster the value-added on cassava. Ghana's PSI on cassava was introduced to boost cassava production yet productivity remains low because farmers cannot break-even (MOFA, 2016). Considering cassava production in Ghana, coupled with the assumption that productivity will increase once new technology and policy interventions are adopted, this left much to be desired since farmers do not adhere to new technology and interventions.

Nevertheless, increases in productivity do not rely on adoption rate only, but also efficiency in the use of available technology, acceptable price and market that increase returns. Ayensu starch industrial unit established in Ghana under the PSI functioned under capacity and subsequently became defunct as a result of lack of raw material (cassava): an impact assessment survey conducted revealed farmers were unhappy with low prices paid by the factory, which led to the factory being unable to secure sufficient quantities of raw materials (NPACI, 2008). The issue investigated revealed that cassava producers do not receive maximum returns from the resources committed into production.

Ghana government and other stakeholders in cassava production such as WAAP, CAVA and CSIR are encouraging rural farmers to embrace the contemporary cassava production know-hows such as plot marking, planting in roles etc. These measures are to increase productivity nevertheless, the implementation is encountering several challenges in Ghana (Nweke *et al*., 2002, Teklewold *et al*., 2002).

Cassava farmers in Ghana can be efficient in their production activities if they are responsive to market indicators likewise in utilizing new technologies efficiently to augment productivity. Trade in fresh cassava in Ghana is rather narrow because of the bulkiness and perishability of the roots. Nevertheless, farmers do not take advantage of the global bulk trade which consists of pellets and chips for feed and the balance for starch and flour for food and industrial uses. Linking smallholder cassava farmers to commercial opportunities has the potential of increasing cassava production and subsequently increase in farmers' income. These achievements can be feasible if farmers could consider efficient use of inputs, improved yield and increase in area cultivated.

Getting clarity on the efficacy of production, market factors, and related farm characteristics could give the policymakers data to design programs that can add to measures required to increase cassava cultivation potential of a nation. Considering the aforementioned measures to improving cassava production and their effects on profit efficiency at the farm level constitutes the gaps this study seeks to fill. However, to evaluate the output of cassava agrarians in Ghana is a prerequisite for increasing cassava productivity and farmers' profit in the study areas. To this end, the need for increased cassava productivity and profit provides the basis for this study. Several studies have been undertaken on cassava production profitability (Awerije, 2014), J.O Effiong et al., and I. A Ayinde et al., but these studies were mostly done to determine the net profit margin of smallholder cassava farms. Looking basically at the total output, variable and fixed costs without considering the exogenous factors that may affect production and profit level. Ostensibly, there is a paucity of study on the measurement of profit efficiency regarding cassava production in Ghana. In this regard, the study seeks to estimate the cost and returns and profit efficiency of the two ranked cassava producing regions in Ghana - Brong Ahafo and Eastern. This information is not readily available in Ghana's agricultural literature.

1.3 Research Questions

This study sought to deliver responses to the ensuing queries pertaining to the efficiency levels of profit of cassava production in the Brong Ahafo and Eastern Regions:

1. What are the costs and returns of cassava production in the study areas?
2. What are the levels of profit efficiency of cassava production in the study area?
3. What are the major determinants of profit efficiency of cassava production in the study areas?
4. What are the major limitations of cassava producers in the study area?

1.4 Objectives of the Study

The main objective of this study is to assess the profit efficiency levels of cassava production in Brong Ahafo and Eastern Regions of Ghana.

The specific objectives of the study were:

1. To estimate the cost and return levels of the farms in the study areas,
2. To estimate the profit efficiency levels of cassava farmers in the study area
3. To assess the determinants of profit efficiency of the farmers in the study area,
4. To identify and rank the major constraints of the cassava farmers.

1.5 Relevance of the Study

Measurement of efficiency cannot be overlooked since it plays a vital role as a guide for planning and development and decision making in agriculture. Consequently, agriculture advancement is linked to profitability of an enterprise and its efficiency measurement. The investigation of farms productivity by means of monetary proficiency need not be hypothetically restricted to commercial farms because, if the necessities of the homes are fulfilled, smallholder farms may basically turn to profit-generating entities which also need to be considered in the determination of profit efficiency. These market and household indicators are very important because they help cassava growers in Ghana to adopt sustainable and highly productive systems to improve upon the use of scare resources.

Cassava cultivation is mostly held sway by smallholder producers who account for the chunk of the nation`s requirement for cassava. Despite the special and essential positions held by these small-scale farmers, they are among the poorest of the populace who get their livelihood and jobs from cassava farming and as such cannot invest much in their farms. Invariably, this study on profit efficiency is important because the assessment of effectiveness level of cassava farmers in Ghana will improve and sustain production levels amidst the utilization of scarce resources.

Assessing the performance of cassava production and profit efficiency of cassava farmers can be informative to the national policy by evaluating the consequence of lack of government interventions on the rare economy of cassava production. Getting credible data for analysis of cassava production will improve farmers' productivity through the identification of good agronomic practices linked with efficiency and profitability.

Cassava is a major crop considered as a non-traditional export crop in Ghana. Government, stakeholders and policymakers would be interested to assess cassava producers' profit efficiency levels so as to be able to espouse on modifications based on the predominant economic circumstances. The determination of profit efficiency level is useful to cassava producers and stakeholders in understanding how profit efficiency can affect production and a monetary analysis, governance and competitive factors. This will facilitate the approaches to bridging the efficiency gap hence increasing cassava production of farmers in Ghana.

From this study, the cassava farmers' constraints will be ranked and this will create awareness to cassava producers, stakeholders and government in making prudent policy formulations to sustain and improve cassava production in Ghana. This would be done by educating farmers on the necessary steps to minimize the constraints.

Lastly, the study will plug the knowledge cavity in profit efficiency regarding cassava production in Ghana. Furthermore, it would contribute to the array of literature on cassava production in the country and globally.

1.6 Organization of the Study

This research work is presented in five chapters. Chapter one constitutes the background of the study, problem statement, the objective of the study, research questions, relevance of the study and the organization of the study. Chapter two presents a review of pertinent literature, both theoretic and empirical. In chapter three, the methodology in terms of empirical modelling of efficiency estimation, the variables and their measurements, the type of data used and how the analysis was done are presented. Chapter four presents the results and discussions of the study. In chapter five, the study's findings, conclusions, and recommendations are provided.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides information regarding the performance of cassava subsector in Ghana and the World, constraints to cassava production, the definition of efficiency and frontier estimation methods. The chapter also outlines stochastic frontier analysis, profit function model theory as well as the impact of profit function approach on the production function. The chapter also considered the pragmatic evaluation of efficiency studies in agriculture in Ghana.

2.2 Cassava Market Growth and Opportunities

According to Grow Africa (2018), international trade in cassava products has grown by over 10% in the last five years. China's imports accounted for about 90% of global total trade. The growth in China's demand for cassava can be traced back to 2006 when the Chinese government restricted the use of molasses and maize as the principal input for ethanol production. These trade barricades were intended at checking the environmental effects of waste from using molasses and curbing an increase in food commodity prices. China is the largest exporter of textiles in the world and thus requires significant quantities of cassava starch for that industry as well.

Thailand and Vietnam are the world-leading exporters of cassava and its derivatives, contributing approximately 95% of the world traded volume in 2013 (Grow Africa, 2015). The free trade agreement between China and Thailand in 2013 which abolished 6% operationalization tax on cassava products from Thailand's to China have enhanced cassava production in Thailand. (Grow Africa, 2015). This policy affected the market price of imported cassava starch hence, Chinese manufactured starch became lower, which eventually further increased global trade (Grow Africa, 2015).

In spite of accounting for the mainstream of cassava produced globally, African states` contribution to global trade of cassava products is nearly insignificant (Africa G, 2015). Uganda is the continent's largest exporter; however, it positions twelfth worldwide with exports of 9,000 MT of fresh or semi-processed cassava and 1,300 MT of starch in 2013 (Africa G, 2015). These exports are principally intended for neighbouring nations within the East Africa community, with little volumes exported to the United Kingdom. Rwanda and Tanzania also contribute marginally to the cassava trade, with small volumes of flour and pellets being sold to Belgium and the European Union respectively (FAOSTAT, 2013; DATCO, 2017).

A study by (Grow Africa2015) asserts that cassava starch demand for industrial use in Ghana and the Sub-Sahara Africa market is projected to increase to 1.6 million per year.

According to Naziri *et al.* (2014); RTIP (2004) and FAO (2001), over half a billion people depend on cassava for their livelihood of which 300 million are in Africa. However, in addition to direct human and animal consumption of cassava roots, cassava starch has great potential in the industry. The demand for starch as an industrial raw material for both food processing industries such as the pastries producers and non-food industries such as the pharmaceutical and textile producers have been on the rise lately.

The use of other raw materials for the production of ethanol is restricted. Given this; China currently imports millions of tons of cassava chips to produce ethanol. According to Zhou & Thomson (2009), even though African countries make up the majority of cassava producers worldwide, they do not play a significant role in the world trade of cassava products.

According to Kleih *et al*. (2013), the number of investments in ethanol and starch suggests the growing potential to add value to cassava. These investments are inclined to catalyze interest in improving the value chain to promote growth hence generate profitable returns for the farmers engaged in the cassava production

Cassava production in the Sub-Sahara region of Africa may possess the potential to generate the intensification of production needed while minimizing the cost of production per unit. In spite of the extensive subsistence nature of cassava cultivation, particularly in Africa, the crop has a lot of by-products which serve as a great potential for further use in industries, for instance, food and the pharmaceutical industries. The primary industrial products that are prepared with cassava include cassava flakes, high-quality cassava flour (HQCF), ethanol and starch. According to Nweke (2004), cassava has great potential in international trade. Nweke (2004) asserted to the fact that demand for the derivatives of cassava such as gari, starch, tapioca, and many others has doubled in the last two decades. According to Nweke (2004); Knipscheer *et al*. (2007); Ayoade & Adeola, (2009) sixteen (16%) percent of this root crop are processed in Africa for domestic industrial uses and export.

Kleih *et al*. (2013) assert that there is a large opportunity for cassava industrial and commercial growth in Ghana. Surplus production of 30 to 40% on top of subsistence needs suggests that much of this excess cassava is either wasted or remains unharvested, and thus it can be captured for industrial use without any effect on food security. Ghana has also had successful experience with industrial uses of cassava following a thriving cassava chip export business to Europe in the 1980s

Cassava chips are more stable intermediate products than fresh cassava. Consequently, it is often used in the production of animal feed for export. High-Quality Cassava Flour (HQCF) can be added to wheat flour to create composite flour for the production of bakery products (bread, cookies, snacks and pastries). Nweke (2004) revealed starch is widely used in the industries for products such as food, beverages, pharmaceuticals, textiles, adhesives, paper, plywood. Ethanol is generally used in the production of alcoholic beverages as well as for pharmacological and industrialized sterilization, more so, serving as energy for food preparation or mixing gasoline in cars

In Ghana, fresh cassava root is mainly cultivated for human consumption. However, the use of cassava for commercial purposes is on high demand due to greater acknowledgement of their industrialized potentials (Jumah *et al,* 2006). Jumah *et al* (2006) also asserted that income generated through cassava cultivation and cassava post-harvest processing accounts for approximately one-fifth of the agricultural GDP in Ghana. Countless individuals are undertaking activities connected to cassava, which greatly contribute to generating income for both genders.

Enormous prospects exist for growing income from cassava farming, coupled with the mounting attentiveness in the use of cassava as raw materials in diverse industries. According to Hart (1973), this is owing to myriad elements comprising technological fluctuations and exchange rate of the USA dollar to the Ghana cedi. Cassava is a multifaceted crop which is finding many industrial applications, including well-drilling, adhesives, foundries, wood furniture, bio-fuels, dusting powders, plastics, packaging, corrugated boards, textile industry, paper industry, drugs, concrete stabilizer and alcohol products.

2.3 Performance Analysis of the Cassava Industry in Ghana

The total cassava production in Ghana was estimated at 18,470,762MT in 2017 (FAOSTAT, 2017). This reflects 6.3% of the world production, indicating the total local output irrespective of its position in the agricultural sector, consequently, incorporates non-industrialized production and production from backyards. Production is dispatched at the farm level (FAOSTAT, 2017). The top five producing Regions are: Eastern Region – 4,466,906MT, Brong Ahafo – 3,747,940.65MT, Ashanti Region – 2,613,347.9MT, Central Region – 1,898,457.76MT and Northern Region – 1,427,541.19MT, respectively (MoFA, 2017). The trend of cassava production in Ghana is illustrated in Figure 2.1.

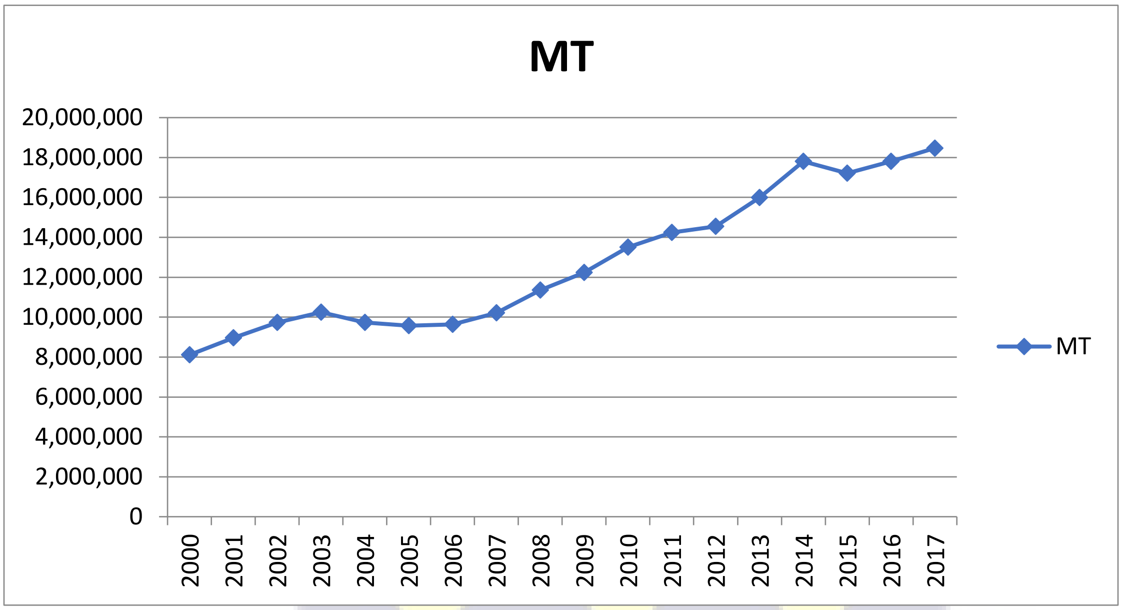

Figure 2. 1: Trend of Cassava Production in Ghana
Source: FAOSTAS (2017)

Figure 2.1 shows that the output level of cassava production in Ghana increased between the years of 2000 to 2003 from 8,106,860MT to 10,239,340MT respectively. The increase was due to the Presidential Special Initiative on Cassava initiated in 2001. However, output level slightly decreased in 2004 – 2006 from 10, 239,340MT to 9,638,000MT due to disease infestations, post-harvest losses, and low farm gate price. Output then rose steadily from 2007 till 2014 (10,217,930MT - 17,798,217MT). The increase may plausibly be ascribed to the introduction of high yielding and disease-resistant varieties of cassava cultivated. In 2015, output again slightly decreased to 17,212,217MT. Thereafter, it then rose in 2015 to 2017 steadily, indicating that the level of average yields in Ghana is well below the achievable yield of around 28,000,000 MT as projected by the Ministry of Agriculture (MoFA, 2010).

2.4 Industrial and Commercial Uses of Cassava

Notwithstanding the extensive smallholder production of cassava, particularly in Africa, it`s derivatives have an immense prospect for use in modern processing. Given its adaptability and high starch content, cassava can undergo transformations into numerous significant items. Cassava's derivatives are extensively categorized into four end products, which are, cassava chips, ethanol, high-quality cassava flour (HQCF) and starch.

Ethanol is utilized chiefly in the spirit extracting industry. Its portable form is known as Extra Neutral Alcohol (ENA), is blended with water and flavours to produce varied alcoholic beverages. Ethanol can also be used as a fuel, both for cooking and for blending with gasoline in vehicles. Ethyl alcohol is used in the medical and industrial sectors as a sterilizer and the pharmaceutical sector as an ingredient in certain medication formulas.

Cassava chips are utilized for the production of animal feed locally. Cassava chips similarly account for the majority of cassava traded internationally, as they are a stable intermediary product that can be shipped and then converted to final products like starch and ethanol. High-Quality Cassava Flour (HQCF) is used largely as a composite flour for bread, biscuits, snacks and pasta. In a few instances, HQCF is also used as a glue extender in the production of plywood, when available at a lower cost than other flours.

Cassava starch is utilized in the food and beverage industry for manufacturing of culinary cubes, drinks, among others. When processed further, native starch can be converted to modified starches like glucose (and related sugar syrups maltose and fructose), sorbitol and destrins. These products have countless uses across industries, including as sweeteners in the food & beverage industry and as other inputs for the manufacture of personal care products like toothpaste, cosmetics, and medicines. Products derived from cassava are used in many parts of the world, indicating the high potential cassava has for value-addition and industrial usage.

2.5 Agricultural Productivity and Efficiency Concept

The outputs of agents deemed economic is estimated as a scalar proportion of outputs to inputs that the agent uses in its production cycle. As indicated by Haghiri (2003), productivity is estimated either as fractional productivity, for example, produce per hectare (land productivity) or produce per individual (labour productivity) or as Total Factor Productivity (TFP) which is characterised as a proportion of total yields to aggregate inputs. An economic agent's profitability may fluctuate based on variations in production technology, production process efficiency, the environment in which the production occurred, and the quality of inputs used by the agent.

In ensuring that measures of productivity is reliable and lined up with the monetary hypothesis, yield should evaluate the overall productivity of a particular production cycle that conglomerates intermediary inputs in order to create a product. It is tallied if the item is traded for local consumption, including consumption by the agrarian household, for international trade or added to inventories.

Decreasing farm losses straightforwardly lead to greater efficiency, as it would prompt higher yield with no supplementary input cost. Farm-gate costs are used to estimate the output. To gauge the basic productivity, cost of output ought to be the net of subsidies gotten or taxes paid. These costs are likewise alluded to as fundamental costs.

According to Kalarijan & Shand (1999), the execution of an enterprise is decided through the conception of money related effectiveness which encompasses technical effectiveness and allocative efficiency. Each profit-oriented organisation is effective when it can produce a greater yield with a given number of inputs or an indicated yield with a small amount of a given resource (Vensher, 2001). Comparatively, Ellis (1988) asserts the fact that technical efficiency is to acquire the ideal level of yield from a set of inputs through the utilization of an accessible range of alternative technologies. However, technical efficiency in its measurement is classified as old neoclassical economics, based on evidence that neoclassical economics adopts full technical efficiency. Kalarijan & Shad (1999) asserts the measurement of technical efficiency is justified by, the gap that subsists in the efficiency realized and the theoretic supposition of complete technical efficiency. Bauer (1990) and Kalarijan & Shad (1999) observed that, amidst technical inefficiency, there is a need for an inverse effect on allocative effectiveness with a direct impact on economic efficiency.

Changes in technology occur stage by stage, firstly, it produces a larger amount of yield for the similar or lesser units of input than older procedures. According to Ellis (1988), researchers argue that introducing new technology to the production process renders preceding procedures in principle ineffective. However, Meier (1995), in the context of efficient research, technology involves a sequence of known strategies for producing a specific output. The development of another innovation does not ensure its availability to all producers, particularly, small scale farmers. Two types of inefficiency are realized because of inefficiency occurring from operating off the isoquant and inefficiency as a result of the inability to migrate to a diverse isoquant when there is an introduction of new technology (Ellis, 1988). The previous can be illustrated when the same output of a particular crop say cassava can be obtained by using a small unit of a given means.

An illustration of the latter is when modern innovations are introduced and a farmer is not able to utilize it for apparent reasons.

Ellis (1988) revealed two technological changes or processes; firstly, process innovation, which deals with improvement in the production of products that are already in existence; secondly, product innovation, which deals with the development of improved outputs which are sustainable. Technological changes signify innovation and improving technical efficiency under a given technology (Fare *et al*. 1997). Primarily, the fundamental idea of calculating technical efficacy depends on the description of product innovation. Production technologies are typically revealed by profit functions, costs functions, production functions, or isoquants. Xu & Jeffrey (1998), Khem *et al.* (1999) and Gavian & Ehui (1999) have directed researches that appraise the effectiveness of agricultural production.

According to Xu & Jeffrey (1998), research that is empirical in nature in the estimation of production efficiency used a variety of modelling methods including parametric versus nonparametric, deterministic versus stochastic and programming methods versus statistical methods.

Broadly speaking, the production efficiency estimation techniques are grouped into nonparametric mathematical programming approaches and stochastic frontier production approaches (Khem *et al.,* 1999). Ceolli (1995), performed a critical analysis of the strengths and weaknesses of the said approaches. Analytically, stochastic frontier approaches have key strengths in dealing with the factors beyond the control of the researcher and measurement errors (stochastic noise). It also allows for a statistical test of hypotheses pertaining to the production structure and the degree of inefficiency. The shortfalls of stochastic frontier approaches do not exclude the prerequisite to enforcing an unequivocal parametric form for the technology in question.

According to Yevu (2013), the strengths of the nonparametric approach, called Data Envelopment Analysis (DEA) include parametric specification of technology which avoids distributional presumptions of the inefficiency variable. Basically, the weakness of DEA approach is that; the deterministic points all aberrations and abnormalities from the boundary to inefficiencies which subject the model to the evaluation of errors in the dataset. In stochastic frontier approach, technical linkages among inputs and outputs of a production cycle are depicted by production function that sets up the greatest yield accomplished from a given vector of input variable known as the production frontier. The influential work of Farrell (1957) is a follow back to the production frontier efficiency. The Stochastic Production Frontier (SPF) was advanced by Aiger *et al.* (1977) and Meeusen & van den Broeck (1977).

Review of specific methodologies used by earlier researchers is significant. Their work adopts dual stochastic frontier efficiency decomposition model though Khem *et al.* (1999) moved ahead by relating it to a nonparametric method using the same data set. The most popular stochastic frontier function employed by each research indicates that; Y represents output, X is input vector and β the vector of production function parameters, V is a random error term with zero mean, and U, a nonnegative one-sided error term which gives a measure of inefficiency. The two groups of researchers made use of the Cobb-Douglas functional form, which characterized by less flexibility compared to the translog functional form which is self-dual and has been used in many empirical studies.

Appropriate methods of estimating efficiency and inefficiency of equations are existent. The methods include the optimum possibility process, the Corrected Ordinary Least Square (COLS) method and Zellner's Seemingly Unrelated Regressions (SURE) approach (Jaforullah & Premachendra, 2003). The use of COLS in stochastic efficiency estimation leads to parameter estimates which are undercast in terms of their efficiency, particularly the intercept when compared to maximum likelihood estimates (Greene, 1980). The stochastic frontier model is nonlinear, which results in the production of consistent and efficient estimates by its estimation procedure (Greene, 1995). Greene (1995) opined that, by merit, OLS provides best linear unbiased estimates and computed standard errors at the slope, however, it provides estimated intercept which is downwardly biased. Consequently, Green suggests that the intercept that is computed using OLS should be adjusted by the largest positive OLS error. The two-step procedure submitted by Green is what is referred to as the Corrected Ordinary Least Squares (COLS) method. Estimation of the determinants of inefficiency has brought forth substantial debate in the studies of frontier. Khem *et al.* (1998) stated that the estimation of efficiency scores is the most popular procedure which, regress the efficiency scores against a set of identified factors. Alternatively, nonparametric or analysis of variance (ANOVA) can be used. Kalirajan (1991) and Ray (1988) stood for the two-step procedure, Kumbhakar *et al.* (1991), Battese & Coelli (1995) critiqued the approach by contending that, the identified factors should be merged directly in the estimation of the production frontier because such determinants affect efficiency directly. Nevertheless, Green error correction two-step procedure remains quite popular in examining the relationship between efficiency and identified variables (Khem *et al.* 1998). There is a paucity of literature that seek to integrate particular outcomes directly into the frontier model or in other words are restricted to the parametric approach. On the same pace, the expression of the inefficiency effects as an explicit function of a variable vector and a random disturbance, besides the estimation of all the parameter estimates in a single-stage maximum-likelihood procedure is limited (Reifschneider & Stevenson, 1991).

Bonilla *et al.* (2001) suggest a model for a stochastic production function which reveals the effects of technical inefficiency are expressed as a function to some specific factors in addition to input variables of a production frontier that interacts with the identified factors.

The measurement of production performance takes different approaches. Abdulai & Huffman (2000) assessed the profit efficiency of rice farmers in Northern Ghana. In this study, a farmer is expected to behave based on experimentally testable rules comprising of profit maximization. Farell (1957) used the graphical approach of input-oriented and output-oriented measure production performance. The graphical approach explains the extent to which firms could minimize inputs to produce a certain output (input-oriented) or how the output could be increased based on given inputs (output-oriented). The choice of a certain approach depends on the researcher and the common concepts. However, the widely used approach is the econometric method which gives room for the testing of hypothesis.

2.6 Econometric Approach to Measuring Efficiency

2.6.1 Frontier Efficiency Methods

Preceding Farrell's work, an attempt was made to measure efficiency by deciphering the normal profitability of inputs and then constructing efficiency indexes. Be that as it may, these strategies were discovered to be unsatisfactory by business analysts and agrarian financial experts as the techniques witnessed one weakness to another. Evaluating production functions using the traditional least-squares method has been criticized as inconsistent with the designation of production functions. The evaluated functions can be expressed as normal or reaction capacities in the light of the fact that such a regression estimates the average output given amounts of inputs (Schmidt, 1986). This prompted advances in the frontier method, which is a more grounded theoretical method for measuring efficiency. Frontier models are depicted as bounding functions (Coelli, 1995b).

Efficient frontier model classification is important in the study of efficiency and productivity, which in the last decade revealed an exponential increment within the number of methodological and applied works for frontier efficiency calculation or estimation. Farrell (1957) and Fare & Lovell (1978) measured efficiency by considering the input–oriented and output-oriented approach, respectively. There are two main frontier efficiency measurement methods, namely: mathematical programming (non-parametric) and econometric (parametric) approach. Traditionally, these measurement strategies are ordered on whether they depend on suppositions on the utilitarian form of the production frontier. The ones that depend on those suppositions are viewed to be "parametric" while others that do not depend on the suppositions are deemed to be "non-parametric". For example, Malmquist-type approaches utilizing Data Envelopment Analysis (DEA) are non-parametric, while approaches dependent on the econometric assessment of a production function are parametric. In spite of the fact that these techniques depend on various calculation strategies and suppositions, it is intriguing to take note of the fact that the outcomes are usually insignificantly varied from each other (Neff *et al.,* 1993; Sharma *et al.,* 1997).

2.6.2 Non – Parametric Approach

A mathematical programming approach, which is a nonparametric approach compared to an economic approach, significantly reduces the structure of efficient frontier specifications and does not break down in terms of inefficiency and error. Data Envelope Analysis (DEA) is to the highest degree a comprehensive mathematical programming approach. Like any deterministic technique, DEA presumes that deviations in observed costs and minimum costs occur as a result of inefficient behaviour (Maudos *et al.,* 2002). which measures the relationship between generated goods (output) and allocated resources (input) in a linear program. As a result of the optimization, the DEA determines the efficiency score that can be interpreted as a performance measure. Cooper and colleagues (2004) introduced DEA based on the method of calculating the technical efficiency proposed by Farell (1957). The DEA model can be specified assuming a constant return to scale (CRS) or variable rate of return to scale (VRS) and it can be used to break down cost-efficiency into a single component of technical, allocative, and scale efficiency (Cummins & Weiss, 2000).

2.6.3 Parametric Approach

The econometric methodology indicates a production, cost, revenue or profit function with a particular shape and makes presumptions of the distribution of inefficiency and error terms. Parametric methods to efficiency assessment unequivocally consider the presence of production weaknesses, similar to DEA, at the same time, furthermore, they make certain presumptions on the nature of the best practice technology. Sadoulet & de Janvry (1995) proposed to distinguish three groups of parametric techniques; the Stochastic Frontier Approach suggests that the noticed production costs may vary from the cost frontier either on account of inefficiency or arbitrary changes (Maudos *et al.,* 2002). To isolate the inefficiency and random error terms, precise presumptions about their distributions must be made. The inefficiency term ln u is presumed to be half-normally distributed, whereas the error term ln ε is assumed to be normally distributed (Berger & Mester,1997). The boundaries of both distributions are appraised and can be used to find estimations of production inefficiency.

Distribution-free methodology presumes that there is core shortcoming for each firm over time. The central deficiency is distinguished from random error by supposing that the central deficiency is persevering over the long haul, while arbitrary blunders will, in general, offset each throughout the course of time. This methodology is frequently utilized when working with panel data.

The significant benefit of the parametric methodology over the non-parametric methodology is the ability to communicate the frontier innovation in a basic numerical structure. However, the parametric method imposes a structure on the frontier that would not be appropriate. The parametric methodology regularly imposes a restriction on the number of perceptions that can be fact proficient. For instance, due to the uniform Cobb-Douglas form, when a linear programming algorithm is utilized, many technically streamlined observations occur because there are parameters that need to be estimated (Forsund *et al.,* 1980). This methodology can be partitioned into deterministic and stochastic frontiers. The parametric deterministic methodology is additionally partitioned into statistical and non-statistical strategies.

2.6.4 Deterministic Statistical Frontier

Hardly individuals clung to the non-parametric methodology by Farrell (1957). Nearly as an afterthought, Farrell suggested a subsequent methodology. In this methodology, Farrell suggested computing a parametric convex hull of the observed input-output ratios. He recommended the Cobb-Douglas production function for this purpose in the face of inadequate functional morphology at that time. Aigner and Chu (1968) followed Farrell's suggestion. In order to present the frontier in a numerical form, they indicated a Cobb-Douglas production frontier and obliged all annotations to be on or beneath the frontier.

The deterministic production frontier structure is demarcated as:

$$Y_i = f(X_i ;\beta), exp(-u_i), \ u_i \geq 0 \qquad (1)$$

where y_i = output of the ith sample firm; x_i = inputs of the ith firm, u_i is a one-sided non-negative random variable related to the firm's specific factors that contribute to the ith firm's inability to achieve maximum efficiency of production. The one-sided error term u_i forces $y \leq f(x)$. The components of the parameter vector might be assessed either by linear programming (which limits the direct estimator of the residuals according to the limitation that each residual is non-positive) or quadratic programming (which limits the sum of squares of the residuals, according to similar requirements). Despite the fact that Aigner and Chu did not as such, the technical efficiency of each observation can be legally calculated from the vector of residuals, since u depicts technical efficiency. It assumes that $u_i \geq 0$ ensures that $Y_i \leq f(x_i;\beta).\ exp(-u_i)$. In the deterministic frontier setting, there are potential setbacks with maximum likelihood. First, Maximum Likelihood Estimates (MLE) hinge on the option of distribution for u in that various suppositions produce varied results. This is a challenge as there is no previous discussion of the choice of any particular distribution. Furthermore, the scope of the dependent variable (output) relies on the parameters to be appraised (Schmidt, 1976). Schimdt (1986) espoused that an individual`s presumptions regarding the error term shouldn't be controlled by the need to satisfy such circumstances.

2.6.5 Stochastic Frontier Analysis

The Stochastic frontier theory usually presents the producers as a successful optimizer. Parametric and econometric techniques used to estimate the technical efficiency of producers was first proposed by Aigner *et al.* (1977) and Meusen & Van den Broeck (1977).

Conventional econometric techniques are built based on the Stochastic Frontier Approach. It is to maximize production, minimize cost, and maximize profits function parameters using regression techniques where deviations of observed choices are modelled as statistical noise.

SFA provides efficacy estimations or efficiency scores of individual units. Therefore, an individual can recognize those who require intermediation and remedial measures. Additionally, SFA delivers an influential tool for investigating the impacts of an intervention. Since effectiveness scores fluctuate across units, they can be related to the unit´s characteristics like location, size, ownership, etc. Hence, sources of inefficiency can be recognized. The SFA production takes into consideration technical inefficiency notwithstanding the specific random shocks independently in the analysis process. Basically, two factors cause the deviation from the production frontier; the factors that are completely outside the farmer's control and those that can be controlled by the farmer. The SFA deals with the noise and test of hypothesis pertaining to production technology. According to Battese & Coelli (1995), determination of the SFA model can be achieved using ''corrected'' least square method COLS) also known as the maximum likelihood (ML) method. The ML estimator gives more asymptotically consistent estimates (Battese & Coelli, 1995)

2.7 Theory of Profit Function Model

The profit function gives an alternative approach to the analysis of the production process. For any production function satisfying the desirable properties, dual profit function does exist which satisfies certain desirable characteristics (Isik & Hassan 2002). According to Sadoulet & De Janvry (1995), it is assumed that a farmer will select a combination of variable input and output which will maximize his profit based on the technological limitations available to him in the production process. In general, one can consider profit function instead of the production function for empirical analysis (Lau & Yotopoulos, 1972).

Suppose a farmer has a production function;

$$Y = f(Xi, Z_k) \qquad (2)$$

where Y is the output, Xi represents the variable inputs, and Z_k stands for the fixed factors in production. The variable profit function (thus, current revenue less current total variable costs) would be written as:

$$\pi = P.f(X_i\ldots\ldots,X_j;\ Z_i\ldots\ldots\ldots Z_k) \quad (3)$$

Where π is the variable profit in normal terms, P is the output price, and Xi is the price of variable factors i. Profit function is capable of showing the influence of input prices, output price and fixed factor on profit in the production process (Rahman 2003, Hyuha et al, 2007). Profit function in the presence of both technical and allocative inefficiencies can also be identified and estimated using a flexible functional form. Fare and Lovell (1978).

2.8 Profitability Measures

According to Michael Langemeie of Purdue University (2017), profitability is the ability of the firm to generate earnings. Profitability is a relative measurement of a firm's efficiency and ultimately its success or failure. Farm productivity can be estimated utilizing Earnings Before Interest, Taxes, and Amortization (EBITA), net farm income, operating revenue margin ratio, the pace of profit on-farm resources, and pace of profit on farm equity. Net farm revenue is utilized for household upkeep, to pay back debt, and to procure new and used assets. In spite of the fact that these two measures are enormously critical to monitor heuristically on a specific farm, owing to the fact that these measures hinge on on-farm size, it rarely makes sense to contrast EBITA and net farm revenue with other farms. Since they consider farm size, the profitability measures other than EBITA and net farm revenue are more beneficial when making distinctions among farms. Notwithstanding, these two estimates are sensitive to how farms resources are esteemed on the accounting report or balance sheet. Consequently, the operating profit margin is more favourable for benchmarking profitability among farms. This research would consider the two major ways of measuring farm business profitability; Gross Profit Margin and Net Farm Income.

2.8.1 Gross Margin

The gross margin or the income above variable cost for each enterprise is needed to be considered for the selection of a crop. The higher the gross margin of the crop enterprise, the more it will be preferred. A gross margin estimated for a crop enterprise is the variability in total income and total variable cost. Viewing gross margin from another prism or lens is by considering it the enterprise's contribution to fixed costs and profit after settling the variable costs. A Gross Margin is basically the degree of variability in the Gross income earned by an enterprise and the direct costs (or cost of inputs) essential for production. It is a significant instrument for utilization by farm enterprises to discern how to assemble and comprehend the resultant values. Specifically, the Gross Margin formula is:

Gross Margin = (yield per ha or acre * price received per unit (e.g. tons or Kg etc.) minus Direct costs. (eg cassava stake, chemical, fertilizer, machinery cost (fuel + R&M) & insurance and casual labour). Therefore, calculating the gross margin of an enterprise requires the yields or production level of that enterprise and price for the output.

According to Hyuha (2006), Gross margin of each crop is generally an excellent marker of the amount a particular crop contributes (referred to as a % contribution) to cover the overhead costs of the farming business and consequently its lowermost line. It is a principal proportion utilized by financiers to help in deciding the capacity of the business to meet instantaneous and upcoming financial obligations.

Having knowledge of the gross margin of crops cultivated and different endeavours you run on your farm is a good planning tool to ascertain how much revenue the different enterprises will potentially generate on the scarce resource (your farm). Indeed, even with the requirement for crop rotation, it is apparent that you would need to grow the crops or manage the enterprises on your land that have the most optimal gross margin benefit.

2.8.2 Net Farm Income

Economists define profit as excess revenue over costs. Basically, two concepts of profit exist: accounting and economic. When calculating accounting profit, only the explicit cost is taken into account and the concept of economic benefit takes into account both implicit and explicit costs (Kolawole, 2006). Therefore, the economic benefit concept records the high total cost and the decrease in gross profit compared to accounting profit. Arene (2000) pointed out that the surrogate hypothesis does not better explain and predict the behaviour of companies over assumptions that maximize profits.

Olayide & Heady (1982) confirmed that all other objectives followed the maximization of profit in multi-dimensional and/or multi-vitiate motivations for corporate purposes. The concept of profitability is derived from the difference between investment cost and return. Profitability refers to the magnitude of profits made in relation to the size of resources used to generate the size and profit of the business (Odii, 1998). In the analysis of agricultural income, the budget method is mainly adopted to measure the profitability of the agricultural business. Profitability measures the ability of farmers to recover costs. It is an integral concept to provide incentives for entry into the agricultural business.

According to Veisi *et al*. (2016), Net Farm Income (NFI) analytical model is a better model compared to the Gross Margin (GM) analytical tool. The NFI, unlike the Gross Margin method, includes the total fixed cost in addition to the total variable cost. Fixed costs have to be covered before arriving at a profit.

2.9 Profit Efficiency

Ali & Flinn (1989) defined profit efficiency as the capability of an enterprise to attain the most optimal profit level, given the cost of inputs and levels of fixed factors for that firm. Profit efficiency is the ability of the enterprise to induce revenues by fluctuating outputs just as it does to inputs. The turnover function from which profit productivities are achieved does not hold all output numbers statistically fixed at their observed, possibly inefficient levels (Isik & Hassan, 2002). Normally, profit efficiency is a proxy for economic efficiency. Producers aim to meet higher levels of economic (cost, revenue or profit) efficiency. The productive efficiency as stated by Kumbhakar & Lovell (2000) can be likened to economic efficiency. Consequently, economic efficiency can be attained by technical efficiency and/or allocative efficiency. It is perceived that the profit efficiency concept is grander to the cost efficiency concept for evaluating the overall performance of a firm (Berger & Mester, 1997). Firstly, profit efficiency is dependent on profit maximization, which needs the same amount of focus to be placed on maximizing marginal revenue as to reducing marginal costs. Secondly, the profit function relates both to the input and outputs deficiencies whereas the cost function provides explanations for only deficiencies in inputs (Vivas, 1997). Finally, a farm enterprise can be unproductive if it yields too few, or a non-optimal mix of outputs given the inputs it uses and the prices it faces as shown by Isik & Hassan (2002).

2.10 Constraints to Cassava Production in Ghana

There is a common agreement in agricultural publications that low output is one primary factor hindering the processing, marketing and investment in agricultural raw materials in Ghana (UNECA, 2009; Sanusi, 2012). Most Ghanaian farmers are smallholders who do not adopt yield-enhancing practices and techniques like the use of agro-chemicals, mechanization, and irrigation.

Research has shown that the economic rate of return of agricultural research on output ranges from 117% for sorghum to 80% for rice, 30% for cassava and 29 per cent for livestock (UNECA, 2009). It has been observed that under-capitalization of agriculture has given rise to a weak knowledge-based sector, leading to low input and low value-added.

MoFA (2017) indicated that pests and diseases are still the main challenges in the cultivation of cassava. Nonetheless, with the correct information and agricultural practices, these could be reduced to the barest minimum and consequently be eliminated.

Land acquisition and tenure systems rarely allow long-term leases of land and present a burdensome process to investors hence create obstacles to growth, particularly for scaling up to the commercial farming operation. In Ghana, the land is owned communally, and the average lease period is 55 years (FAO, 2019). In order to aggregate smaller plots to reach sufficient size, entrepreneurs are forced to deal with many traditional rulers who can each present different lease requirements which makes the overall acquisition process cumbersome.

Sparing in the use of high-quality inputs has been a key impediment to the growth of the cassava sector as the major reason for low yields of between 8-12 MT per hectare. Achievable yields in Ghana can reach 20 MT per hectare and above but farmers tend not to use improved inputs because they are expensive (MoFA, 2017). Also, without strong off-taker opportunities, farmers do not see economic incentives increasing productivity. Low productivity is a constraint to commercialization because it drives high costs of sourcing raw materials and problems securing sufficient supply. Significant losses and un-harvested produce are a secondary constraint. In many instances, farmers leave roots un-harvested when no opportunity exists to sell profitably. These supply chain inefficiencies are driven by poor linkages between farmers with surplus production and off-takers seeking additional raw material. Poor infrastructure, climatic conditions, lack of efficient agriculture extension systems or poor communication among the stakeholders were identified by various actors as factors inhibiting cassava production in Ghana.

Government policies to support the sector have so far fixated on raising productivity and food security, with less focus on commercialization and industrial development (MoFA, 2017). Lastly, cassava farmers' ability to access credit for cultivation remains a challenge (Addy *et al*., 2004).

2.11 Review of Empirical studies on Profit Efficiency

According to Ansah *et al*. (2014) profit efficiency measurement of substitute specialized crops was examined in the Ejura-Sekyedumase District of Ashanti Region of Ghana, using 199 maize and cowpea farmers. The measurement was based on comparative advantage. The stochastic frontier function was used to measure and compare the profit efficiency of farmers growing two crops. The analysis revealed that the profitability of maize farmers was between 47% and 96.7%, the sandwich farmers' earning efficiency ranged from 50.3% to 100%, the average profit efficiency for maize and cowpea was 89% and 95% respectively. It also showed that farm-scale, farm labour participation and education are important factors influencing the profitability of the crops in the research area. Ejura-Sekyedumase farmers aim to improve the welfare of households if available land and other rare resources are allocated to cowpea agriculture.

Oladeebo & Oluwaranti (2012) in the case of Southwestern Nigeria, profit efficiency in cassava production was examined in order to isolate important factors that change the inefficiency of cassava producers' inherent interests to farmers. With the help of a structured questionnaire supplementing an oral interview, the cross-sectional data obtained from 109 representative samples of cassava producers were analyzed using the stochastic frontier to estimate the socioeconomic characteristics and profit efficiency of cassava producers. The percentage of cassava producers in the surveyed area by the analysis of descriptive statistics was used to explain the function. The results pointed out that near 51% of cassava farmers are receiving formal education. Around 50% had agricultural experience of more than 10 years, but the average household size, farm size and age of respondents were 8 people, 3 hectares and 46 years respectively. From the analysis, the profit efficiency of farmers lies between 20% and 91%, but since the average level of profit efficiency was 79%, the profit loss of 21% was inefficient in technical allocation. This survey also showed that household size and farm area are important factors that have a positive effect on profit efficiency. The study concluded that there is a range that enhances profit efficiency in cassava production, focusing on these profit efficiency factors.

Nganga *et al*. (2010) reveal that production inefficiency is usually analyzed using economic efficiency. Economic efficiency consists of two elements: technical efficiency and allocation efficiency. The study by Nganga and colleagues provided a direct measure of the production efficiency of small-scale milk producers in Kenya, using the frontier and inefficiency models of probabilistic benefits. Key data was collected using IMPACT (Integrated Modeling and Platform Integrated Modeling Platform) structured questionnaire comprising four conventional inputs and socioeconomic factors that affect production efficiency. As a result, sampled farmers' profitability varied widely between 26% and 73%, with an average of 60% being estimated by a combination of both technological and allocative inefficiency of small-scale dairy milk. It was suggested that 40% will be lost. In the survey, it was further observed that the efficiency of agricultural education, experience, and magnitude had a positive effect on profit efficiency, and profit efficiency declined with age. This means that as the educational level of sampled farmers improves, the inefficiency of profits among small dairymen can be drastically reduced.

Ettah & Kuye (2017) conducted research on the analysis and factors that influence the efficiency of cassava farmers in Cross River State, Nigeria. This work was done using stochastic frontier revenue functions of the Cobb-Douglas function format. The data for the survey was collected from key sources with the help of a series of structured and pretested questionnaires. With regard to profit efficiency, the minimum and maximum profit efficiency were 0.14 and 0.91 respectively, and the average profit efficiency was 0.65.

The average profit efficiency means that farmers were able to get 65% of the potential profits from the unit mix of the inputs. This means that about 35% of the profit will be lost from management inefficiency. Therefore, in the short term, there is a range that can increase the profit in cassava production by 35%. Age (0.37), education (0.67), household size (0.58) had a positive impact on revenue inefficiency. Analysis of profit inefficiency effect showed significant gamma ($\gamma = 0.86$). This means that a deviation of 86% from the maximum available profit is a result of farmer's inefficiency rather than random error or variability.

The signs and importance of estimation coefficients in inefficient models have important implications for farmers' profit efficiency. Ettah & Kuye (2017) further urged farmers to invest in cassava production for profitability and economic value and should provide input at affordable prices. Improve profit efficiency of input utilization by using appropriate agricultural practices and inputs.

Galawat &Yabe (2012) investigated the profit efficiency in rice production for Burkini Darussalam using stochastic frontier approaches. The most efficient approach to enhancing rice productivity is to use rare resources more efficiently. Galawat and Yabe in their study looked at the production efficiency among rice farmers in Brunei by using probabilistic benefit aspects and inefficient effect models analyzed from three technical, distributed, and scale factors. Empirical results indicate that

19.3% of the benefit is lost owing to the amalgamation of technical, allocative and scale inefficiency with an average profit loss score of 80.7% and an average profit loss of Brunei Dollar 987.50. Factors related to profit loss and profit inefficiency are not membership of cooperatives, no irrigation, lack of training, and low yield varieties.

Kuboja *et al*. (2017) conducted a study applying a stochastic profit frontier model to estimate the economic efficiency small beekeepers in Tabora and Katabi areas in Tanzania. As a result, the profits of small beekeepers are determined by material changes such as workers for honey harvesting, wire and colour paint. Reducing these costs can greatly increase the profits in beekeeping production. Smaller beekeepers were economically efficient, with an average efficiency of 92%. Indicating that there is room for improvement of about 8% without changing the frontier of profit. The main significant determinants of the economic efficiency of small beekeepers were access to contacts of beekeepers by other beekeepers, follow-ups, and beekeeping training to improve management practices. Accordingly, regular and timely extension service and beekeeping training can be carried out among beekeepers.

Olukunle (2016) researched sociological and economic indicators that underlie output and lucrativeness of cassava production in Nigeria using regression and budgetary techniques to analyzed primary data collected from farmers. The results revealed that the major underlying factor of net profit includes: land area cultivated, man-days of labour and marketing cos and age of the farmer. Ten percent increase in area planted resulted in a 4.8 percent increase in output. Ten percent increase in marketing cost brought about 5.5% decline in output, while 10% increase in age of the farmer-led to 3.8% decline in output. Majority of the farmers sold their products at the farm gate to avoid high transportation cost.

A Malaysian study by Kaka *et al*. (2016) analyzed the profitability of paddy farmers using the probabilistic frontier production function of Cobb-Douglas. A multiple regression model grounded on probabilistic frontier profit function assuming the Cobb-Douglass specification was estimated by multistage random sampling method using cross sectional data obtained from 397 paddy household samples. With the maximum likelihood estimate of a particular profit model, the producer's profit efficiency varied from 30.5% to 94.8%, with an average of 73.2%, paddy's combination of technical and allocative inefficiency makes for profitability. Production suggested that 26.8% will be lost. As a result of the technical inefficiency model, it is clear that access to credit, education, agricultural experience, extension service, MR219 variety, broadcasting planting law, machine broadcasting law and herbicides are important factors affecting the inefficiency of revenue. This shows that as the level of the sociological and economic features of the studied farmers improved, the inefficiency of profits in paddy field production is greatly shortened.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the insight into the research methods adopted in this study. It takes up a central question relating to the methodology used to address the varied objectives of the study. It also looks at the conceptual framework, theoretical framework and the models of analysis specified for each objective. It discussed the study area, methods of data analysis, model specification, description of variables, and the sampling technique of the respondents.

3.2 Conceptual Framework

The conceptual framework is built on production theory by applying probabilistic revenue frontier function. It demonstrates the influence mechanism of the feedback flow and the profit efficiency level on the farm level. It centres on internal or farm-level factors (input-output conversion efficiency) and their impact. Production factors (the price of planting materials, price of farm tools, price of agrochemicals and expenditure on labour) were used as cassava production inputs. The input is expected to be applied by farmers to increase yield. Cassava yield increases, but on the contrary, it has a negative effect in the case of overused input. Therefore, optimality is a deciding factor in determining the level of inputs to be applied (Sibiko, 2013; Karani, 2013).

The extent of profit efficiency is affected by the production efficiency of cassava farmers. The Socio-economic and institutional factors that are to be expected to affect the efficiency of farmers include; age of farmer, agricultural experience, extension contracts, FBO membership, market access, market channels (Sibiko, 2013; Karani, 2013). This is illustrated in figure 3.1

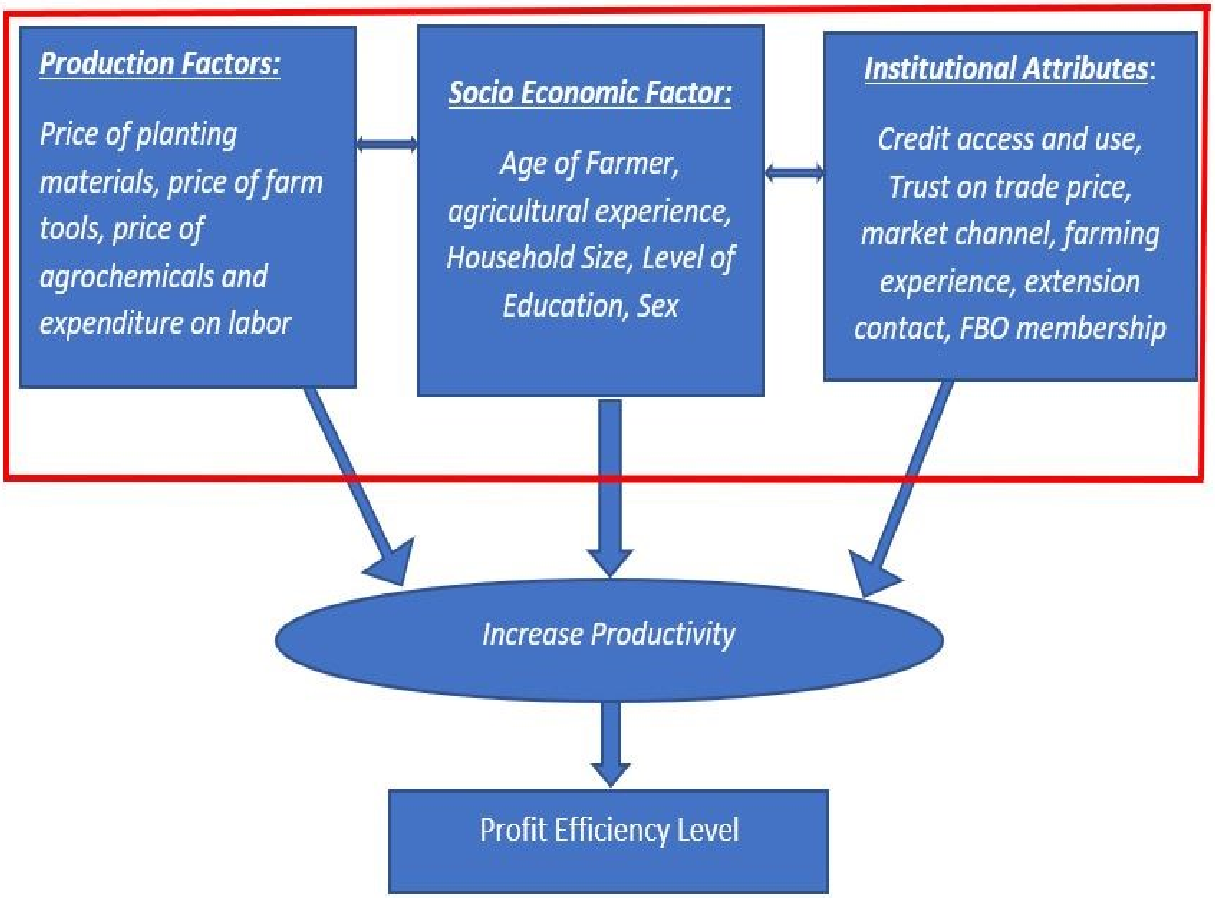

Figure 3. 1: Conceptual Framework
Source: Adapted from Sibiko (2003)

Improvement in the level of profit efficiency of cassava farmers lies partly on improvements of inputs such as planting materials, farm tools, agrochemicles and labor, socio-economic characteristics for farmers such as age, experience household size etc, access to institutional services such as credit, efficiency of return, feedback to institutional and socio-economic factors (Sibiko, 2013).

3.3 Theoretical Framework

3.3.1 Methods in Measuring Efficiency

Farrell (1957) looked at measuring efficiencies in different fields. However, research by Aigner *et al.* (1977) and Meeusen &Van den Broeck (1977) proved to be valuable by modelling and estimation of stochastic frontier approach (SFA) in the area of agriculture. Coelli (1995) and Thiam *et al.* (2001) have done a critical analysis of farm-level efficiency in developing countries.

According to Coelli (1995) and Thiam *et al.* (2001), there are some theoretic concerns that ought to be considered when gauging effectiveness in the context of frontiers. These theoretical issues include a sampling of functional forms and their germane methodologies.

3.3.2 Theoretical Framework of Stochastic Frontier

The stochastic frontier addresses shortcoming with the introduction of 'v' into the deterministic model in order to produce a composed error term model. The stochastic frontier function is an enhanced methodology of modeling output of enterprises which adopts absolute efficiency in the choice of resources. A stochastic profit frontier model takes into consideration accidental factors outside the control of the producer. This characteristic attempt to remedy the noise problem characterizing deterministic frontiers where measurement errors and any other source of variability in the dependent variable are entrenched in the error term (Hyuha, 2006). The fundamental notion lies in the introduction of an additive error term comprising of a noise and an ineffective term. The splitting of the error term into two gives further clarification of the observed deficiencies and additional efficient parameter coefficients (Thiam *et al.,* 2001; Kumbhakar, 2001). On this premise, profit efficiency of cassava farmers was examined by deploying the stochastic frontier procedure.

From the theory of production, a producer is presumed to select a grouping of variable inputs and outputs that optimizes profits according to the underlying limitations in technology. The production function can be generalized as f (y, x, z) = 0, where y is a vector of output, x, a vector of variable inputs, z, a vector of fixed inputs and f is the underlying production technology. Supposing a uniform production technology across farms, restricted profit function can be specified thus (Kalijaran, 1985; Lopez, 1982):

$$\text{Max } p\,y - w\,x, \tag{1}$$

$$\text{s t. } f\,(y, x, z) = 0$$

Where;

p is a vector of output prices and w is a vector of variable input prices. Given a set of inputs and outputs, the profit-maximizing input demand and output supply functions are respectively expressed as:

$$X = x\,(p,w,z) \tag{2}$$

$$Y = y\,(p,w,z) \tag{3}$$

Substituting (2) and (3) into (1) derives the profit function. This is the maximum profit that a farmer can obtain given the output price p, input price w, quantity of fixed input z and the production technology f (.).

The profit function is expressed as:

$$\Pi = p\,y\,(p,w,z) - w\,x\,(p,w,z) \tag{4}$$

The stochastic profit frontier model:

The profit function in the presence of both technical and allocative inefficiencies is implicitly expressed as (Rahman, 2003; Hyuha*et al.,* 2007):

$$\pi_i = f(P_{ij}, Z_{ik}).\exp(\varepsilon_i) \tag{5}$$

Where;

π_i= normalized profit of the ith farm defined as revenue less costs divided by a farm-specific price

P_{ij}= price of jth variable input faced by the ith farm divided by a farm-specific price

Z_{ik}= level of the kth fixed factor used on the ith farm, ε_i = error term

i = 1,2,……,n number of farms in the sample

j = 1,2,…….,m number of variable inputs used

The error term is assumed to behave in a manner consistent with the frontier concept (Ali & Flinn, 1989):

$$\varepsilon_i = V_i - U_i \tag{6}$$

Where;

V_i assumed to be independently and identically distributed N(0, δ^2v), two-sided random error independent of the U_i. U_i are non-negative random variables associated with the inefficiency in production which are assumed to be independently distributed as truncations at zero of the normal distribution with mean;

$$\mu_i = \delta_0 + \sum \delta_d W_{di} \tag{7}$$

and variance δ_u^2 (|N (μ, δ_u^2)|).

Where;

W_d = d^{th} explanatory variable associated with inefficiency on-farm i. δ0 and δd are parameters to be estimated

Individual firm efficiency score is determined as:

$$Efficiency = E\left[\exp\left(-\frac{U_i}{\varepsilon_i}\right)\right] = E\left[\exp\left(\delta_0 - \sum \frac{\delta_0 W_{di}}{\varepsilon_i}\right)\right] \tag{8}$$

Where $Efficiency$ is the efficiency of firm i relative to the best performing firm. The Battesse & Coelli (1995) approach was utilized in this study by proposing a profit function which is presumed to be consistent with the model of the stochastic frontier. Previous researches in this domain include Kumbhakar (2001), Yevu & Onumah (2021), Rahman (2003), Kolawole (2006) and Okoruwa *et al*. (2009).

3.4 Method of Data Analysis

3.4.1 Estimation of the cost and return levels of the farms in the study area

The Farm budgeting method was utilized to determine the rate and returns of the cassava farms, using the Net Farm Income (NFI) analysis. According to Veisi *et al.* (2016), Net Farm Income analytical model is a better model compared with that of the Gross Margin (GM) analytical tool. The NFI, in contrast to the Gross Margin method, includes the total fixed cost in addition to the total variable cost. Fixed costs have to be covered before arriving at a profit. Mathematically,

$$\text{NFI}_i = TR_i\text{-}TC_i \tag{9}$$

$$\text{NFI}_i = TR_i - (TVC_i + TFC_i) = \sum_{i=1}^{N} P_i Y_i - (\sum_{j=1}^{j} C_{ij} VX_{ij} + \sum_{k=1}^{k} C_{ik} FX_{ik}) \quad (10)$$

where; TR_i= total value of cassava production in GH₵ for i-th farm, TC = total cost of production, TVC = total variable cost in GH₵ for *i-th* farm, TFC = total fixed cost in GH₵ for *i-th* farm, P_i = price per cassava by the i-th farm, Y_i = the quantity of cassava by the i-th farm, C_{ij} = the unit cost of j-th variable input used by the i-th farm, VX_{ij} = the quantity of *j-th* variable input used by the i-th farm, C_{ik} = unit cost of *k-th* fixed input used by the i-th farm, FX_{ik} = quantity of k-th fixed input used by the i-th farm. Note the j is suppressed.

Variable Cost Components:

Planting Material Cost, Cost of Manure, Price of Manure, Price of Herbicides, Price of Insecticides, Overall Labour Fee, Overall Marketing Cost, Transportation Cost and other cost.

Fixed Cost Components:

Land rental Cost, Depreciation of Tools using the straight line mehtod.

3.4.2 Estimation of the level of profit efficiency of the individual cassava farmers

The stochastic frontier model was adopted to analyze the profit efficiency of cassava production in Brong Ahafo Region and Eastern Region of Ghana.

Table 3. 1: Description of Variables for Profit Efficiency Estimation

Variable	Description	Measurement	A-Priori Expectations
Π	Normalized profit of the *J-th* cassava producer		
P1	Price of Labour	Continuous variable (GHS/man-days)	+/-
P2	Price of planting materials	Continuous (GHS)	-
P3	Price of Agrochemicals	Continuous (GHS/Ltr)	-
P4	Price of farm tools	Continuous (GHS)	-

Incorporating the profit inefficiency effects in a modified translog profit frontier model specified as:

$$In\pi_i = \beta_o + \sum_j^4 \beta_j lnP_{ji} + 0.5 \sum_{j=1}^4 \sum_{k=1}^4 \beta_{jk} lnP_{ji} lnP_{ki} + v_i - u_i \qquad (11)$$

Where: In = natural log, j-th = farm, π = normalized profit, β_o, β_j, β_{jk} = parameters to be estimated, P_{ij} = normalized variable input prices (Coelli *et al.,* 1988).

The inputs used in the model are Labour, Planting materials, Agrochemicals, and Farm Tools (Hoe, cutlass and knapsack spraying machine).

Price of labour (P_1) in Table 3.1 which is measured in man-days represents the cost of hired labour and family labour normalized by output price on the cassava farms. The measurement of the labour is scaled by the farm size, hence, measured per hectare. The study proposes that the cost of labour is anticipated to be either positive or negative with respect to efficiency.

Price of planting material (P_2) reflects cost of planting materials per a hectare for the cassava farm. It is measured in Ghana Cedis based on the quantity to be used per a hectare of farmland. The study instigates that as the cost of planting material increases it is expected that the efficiency decreases (Arbelo *et al.,* 2018a). Price of agrochemicals (P_3) is the cost of agrochemicals per hectare for the cassava farm. The study proposes that as the cost of agrochemicals increases it is expected that the efficiency consequently decreases.

Price of Farm Tools (P_4) – hoe, cutlass, harvester and boot inform the cost of farm tools used in the operations of the cassava farm. The study proposes that as the cost of farm tools increases the efficiency decreases. Hence the negative sign. See Table 3.1

3.4.3 Empirical Model to Estimate Determinants of Profit Efficiency

The variables considered as underlying influencers on profit efficiency are incorporated in the model below as also specified by Onumah *et al*. (2018), and Onumah *et al*. 2010;

$$\boldsymbol{\mu} = \delta_0 + \sum_{d=1}^{13} \delta_0 Z_{di} \quad (12)$$

where: δ = parameter to be estimated, $\boldsymbol{\mu}$ =non-negative error term, Z = vector of variable explaining inefficient effects, and δ_0 = constant in equation. The variables included in the inefficiency model are presented in Table 3.2.

Table 3. 2: Description of Variables for Determinants of Profit Efficiency.

Variable	Description	Measurement	A-priori expectation
Z_1	Gender	Male=1, female = 0	+/-
Z_2	Age	Years	+
Z_3	Farming Experience	Years	+
Z_4	FBO Membership	Dummy: yes=1 no=0	+
Z_5	Household size	Number of people	+
Z_6	Training	Dummy; yes=1 no=0	+
Z_7	Religion	Christian =yes; otherwise =no	+/-
Z_8	Education	Years	+
Z_9	Main occupation	Dummy; yes=1 no=0	+
Z_{10}	Marital status	Categorical	+
Z_{11}	Access to extension service	Dummy; yes=1 no=0	+/-
Z_{12}	Region	Dummy; Eastern =1; otherwise =0	
Z_{13}	Access to Credit	Dummy; yes=1 no=0	+/-

Hypothesis to Test for Profit Efficiency

1. H_o: $\beta_{ij} = 0$; the null hypothesis that Cobb-Douglas(C-D) profit function is a statistically valid representation of the data (C-D) is an adequate representation of the profit frontier function. The alternative hypothesis is H_A: $\beta_{ij} \neq 0$

Testing the specification of technical inefficiency model would be undertaken by what follows in next point.

2. H_o: $\gamma = \delta_o = \delta_1 = \delta_2 =, \ldots, \ldots, = \delta_{13} = 0$ represents the null hypothesis that at each level, effects of inefficiency are absent from the model (each cassava farm is operating on the profit frontier). The alternate hypothesis is H_A: $\gamma \neq \delta_o \neq \delta_1 \neq \delta_2 \neq, \ldots, \ldots, \neq \delta_{13} \neq 0$
3. H_o: $\gamma = 0$; effects of inefficiency are not stochastic. Under $\gamma = 0$ the traditional average response function (OLS) in which the illustrative indicators of the inefficiency model are incorporated into the production function is reduced by the stochastic frontier model. The alternate hypothesis is H_A: $\gamma \neq 0$
4. H_o: $\delta_1 = \delta_2 = \ldots \ldots, = \delta_{13} = 0$; states that farm-specific factors do not influence the inefficiencies (the variables included in the inefficiency effect model do not affect the efficiency level of profit). H_A: $\delta_1 \neq \delta_2 \neq \ldots \ldots, \neq \delta_{13} \neq 0$ is the alternate hypothesis
5. H_o: $\delta_{region} = 0$, states that there is no regional effect on profit efficiency of production. H_A: $\delta_{region} \neq 0$ is the alternate hypothesis.

The Generalized Likelihood-ratio test (LR) is used to validate the hypotheses stated, LR is specified as:

$$LR = -2\,[\ln\{L(H_o)\} - \ln\{L(H_1)\}] \qquad (13)$$

where $L(H_o)$ and $L(H_1)$ are values of likelihood function under the null (H_o) and alternative (H_1) hypotheses respectively.

The LR has approximately a Chi-square (or mixed Chi-square) distribution, if the accorded null hypothesis is true with a degree of freedom equal to the number of parameters posited to be zero in (H_o). Coelli (1995) proposed that all critical values can be obtained from fitting Chi-square distribution. Howbeit, if the hypothesis testing involves $\gamma = 0$, then the asymptotic distribution obliges mixed Chi-square distribution. Table 1 of Kodde & Palm (1986) shows how the critical value for this test can be acquired.

3.4.4 Model for Estimating Profit and Production Input Elasticity

The profit elasticity in relation to assorted input prices are functions of input prices using the Cob-Douglas/translog function. The elasticity of profit was attained by distinguishing the Cob-Douglas/translog function in relation to input rates. If the variables of regularized turnover and input price are small by the average of their respective samples, the first-order coefficient can be inferred as elasticity of profit for different input prices (Coelli *et al.*, 2005, Yevu & Onumah *et al.*, (2021).

The first order coefficients of the estimated Cobb-Douglas/translog function are used to illustrate the impact of changes in input prices on the level of profitability of cassava farmers in the study area. The production elasticity of the inputs is estimated from the profit function to determine the productivity of various inputs used for production by the cassava farmers. The profit function is a double production function. Therefore, it is possible to indirectly estimate the productivity of the variable and fixed inputs used in production. (Babatunde, 2004).

The identities used are:

$\beta^{1} = -\beta^{*}(1 - u^{*})^{-1}$ (14)

$\alpha^{l} = -\alpha^{*}(1 - u^{*})^{-1}$ (15)

where, α_j^* and β_j^* the parameters, are estimates from the stochastic Cobb-Douglas/translog profit function model whiles $\alpha_j^1$and β_j^1 are the indirect production elasticity for variable and fixed inputs to be estimated respectively. u^* is the sum of the price coefficients the variable inputs prices in the generalized profit. The return to scale was computed by summing the indirect elasticity (productivity) estimates.

3.4.5 Identification and ranking the major constraints of the farmers

The identified constraints (Inadequate capital, Lack of Land for Cultivation, Poor Market price, Lack of improve planting stakes, High cost of tractor services, Post-harvest loss, High transportation cost, Lack of technical assistance and Lack of government support and policy) were gathered during pre-testing and presented to the respondents to rank. The weighted average formula was used to find the mean rank of each constraint. The formula is given by:

$W_{average} = (\sum T)/(\sum m)$ (16)

where, $W_{average}$ = Weighted average, $\sum T$ = sum of ranks for each constraint, and $\sum m$ = Number of farmers. The mean rank with the least value is the most pressing constraint with others following a succession. The Kendall's Coefficient of concordance (W) was used to measure the degree of agreement among the ranks.

$$W = \frac{[\sum T^2 - (\frac{\sum T^2}{n})}{nm^2(n^2-1)} \quad (17)$$

where, T = sum of ranks for each constraint, m= number of respondents, and n= number of constraints ranked.

Hypothesis Testing

The agreement among the rankings was tested using the F-test. The F-test ratio is stated as;

$F\_cal=(([m-1])/W)/(1-W)$ (18)

Hypothesis: The null hypothesis was tested against the alternate hypothesis.

H_o: there is no agreement among the respondents

H_A: there is an agreement among the respondents

Decision rule: if Fcal > Fcrit, we reject the H_o, the conclusion then is that there is an agreement among the rankings of the respondents.

3.5 Study Area

The Eastern and Brong Ahafo (now Bono East, Bono and Ahafo) regions of Ghana were the selected study areas. This owes to their enormous relative merit in the production of cassava. The regions are committed in cassava production as demonstrated by Poku *et al.* (2018). The selected areas have diverse vegetation that spans from thick forest, intermediate to savanna, crudely in lieu of the southern, middle, and northern parts of the regions respectively. They all have a bi-modal rainfall regime. On average, the annual precipitation ranges between 1,088 mm – 1,197 mm which is conducive for cassava production.

Besides, production and marketing opportunities are relatively homogeneous in the two regions. The prices of variable and fixed factors are relatively the same. In respect to marketing activities, the majority of the cassava produced are processed into Gari, cassava dough etc. by the farmers and sold in nearby markets to petty farm produce traders. Some amount of fresh cassava is also sold at the farm gate to the petty traders. They transport the produce to the major cities (Eastern Region – Accra and Brong Ahafo Region – Kumasi) for marketing.

The districts were arbitrarily chosen from each region, two from Eastern region ─ Akwapim North and Akwapim South and two from Brong Ahafo region ─ Dormaa East (now in Bono region) and Asunafo South (now in Ahafo region).

3.5.1 Brong Ahafo Region

The Brong Ahafo region was the second largest region in terms of the landmass in Ghana until it was split into three to create the new regions, Bono, Bono East and Ahafo, by a constitutional Instrument (C.I.) 113. For the purposes of data representations and analysis which were done before the splitting of some of Ghana's regions, this research will use Brong Ahafo region rather than the Bono and Ahafo regions. In aggregate, Brong Ahafo region has a land area of 39,558 square kilometres with 22 administrative districts/municipalities and covers 16.6% of Ghana's total land area. The region has varied vegetative cover, ranging from forest, transitional to savanna. Agricultural activities are common in the micro-economic environment of these areas and yields are high for most crops cultivated there, such as cocoa, teak, oil palm, cassava, yam and maize. Some of its districts, for example, Sunyani West and Berekum districts are semi-deciduous forests, meeting the climatic requirements of most of the region's crops. Dormaa East and Asunafo South districts of the Brong Ahafo region are dominant zones for cassava cultivation. This area was one of the selected areas for the survey as cassava production is high in the district (MoFA, 2016).

3.5.2 Eastern Region

The Eastern Region, with an area of 19,323 square kilometers, covers 8.1 percent of the aggregate land area of Ghana and is the 6th biggest district of Ghana. The forest and savannah soils are reasonable for the production of an assortment of harvests complete with cocoa, cola-nuts, citrus, oil palm, and staple nourishment products, for instance, cassava, yam, cocoyam, maize, rice and vegetables. The area exists in the wet semi-equatorial zone which is portrayed by two-fold maxima precipitation. The main rainy season is of May to June, with the heaviest rains happening in June while the second season is of September to October, with paltry variations between the districts (Ansong *et al.*, 2018).

According to MoFA (2016), the region has high temperatures ranging between 26 °C and 30 °C for August for March respectively. The relative humidity during these high points fluctuates between 70-80%. The area was picked due to the prime significance of the government zone regarding the production of arable crops. The area was picked in light of that it is a prime zone for cassava production. It is additionally nearer to the most populated city (Accra of Greater Accra Region) in Ghana. Along these lines, cassava delivered is transported to consumers in Accra.

Figure 3. 2: The old Map of Ghana indicating regions (Eastern and Brong Ahafo) of the study area

Source: (GSS, 2015)

3.6. Sampling Technique and Analysis

Largely the study was based on primary data which were supported with secondary data. Collecting cross-sectional data for the 2017/2018 production years of 300 cassava farmers in four selected districts of the Eastern and Brong Ahafo regions using a structured questionnaire was achieved using a multi-stage sampling technique.

The two areas were selected by means of a purposive sampling technique due to the high number of cassava farmer in the regions. This was obtained from the 2015 Facts and Figures Publication of MoFA/SRID and interview of the officials of WAAPP and CSIR. The two districts selected in the Eastern region are Akuapim North and South, and Dormaa East and Asunafo South in the Brong Ahafo regions respectively.

Five towns each were randomly selected from the four districts on the basis of the greatest comparative advantage in the production of cassava. A random selection of 90 cassava farmers from Akuapim North, 70 from Akuapim South, 90 from Dorma East and 60 from Asunafo South was made from the list of farmers secured in the various communities. The list of cassava farmers was obtained from the office of respective agriculture community extension officers. Nevertheless, the total number selected for each district was anathema to the total population of cassava farmers based on the list secured with the extension officers in the various selected communities.

Thus, a total of 300 representative farmers were drawn across the selected two regions. The determination of profitability is not necessarily contingent upon the number of respondents. Notwithstanding, the legitimacy of the outcomes hinge on the accuracy of the data; particularly the input, output, and price data than on a large number of respondents. A structured questionnaire was used to gather data on the respondents' bio-sociological and economic variables including age, gender, farm size, farming experience, educational level, marital status, and household size. Additionally, output and input data were collected on variables including the size of the farm, costs of production equipment or implements, stationary assets, revenues, labour (family and hired), input and output prices, wage rate as well as constraints to production and marketing by the cassava farmers. Secondary data were obtained from internet sources, from government, and other relevant stakeholders' publications, case in point, CSIR-FRI, CAVA, AGRA and WAAPP.

The initial step in the estimation procedure of the specified model is the estimation of the correlation coefficient to determine the non-existence of autocorrelation among the variables. Descriptive statistical tools involving means, frequency distribution, and percentages were used to analyse data generated on socio-economic status and constraints to cassava production and marketing. Ordinary Least Squares (OLS) technique was used to estimate the specified model while the budgetary technique was used to analyse costs and profitability of cassava production. Cost of production was disaggregated into fixed and variable costs during a production period. Variable costs are those associated with inputs such as fertilizer, manure, insecticides, herbicides, and hired labour including marketing cost as well as the cost of irrigation water. Other variable costs included the costs of transportation and planting materials.

Expenditure on fixed inputs such as land rent for farming, depreciation of tools and interest rate paid on credits were included as fixed cost components. Gross margin was estimated and this is indicative of farmers' productive capacity while the net profit gives an indication of the actual returns profile after deducting the fixed cost components from the gross revenue. Gross margin and net profits were estimated to assess the level of profitability of cassava enterprise. They are suggestive of the incentives to produce for the entrepreneur. The gross margin that accrued to each farming household in the cropping season was appraised by subtracting the total variable cost from the gross value of output.

Regarding regression analysis, the primary data were fitted with three functional forms of the specified model, namely, linear, semi-log and double-log. Among the three functional forms, the one which produced the best output in terms of sizes, signs, and number of significant parameters estimates, as well as the overall significance of the estimated model was selected as the lead equation.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the study. This includes a description of the various socio-economic characteristics of the respondents, an estimation of the cost and return levels, determinants of profit efficiency and the constraints affecting cassava production.

4.2 Socioeconomic characteristics of respondents

The socio-economic characteristics of the respondents are presented in Table 4.1, Table 4.2 and Figure 4.1. The variations between socio-economic characteristics in the two regions are quite little. Table 4.1 shows that both study areas were dominated by male (63%) cassava farmers. Approximately 61% and 65% of the farmers in the Eastern Region and Brong-Ahafo Region respectively are males. This conforms with Yuguda *et al.* (2013) and Awotide *et al.* (2015) findings, where only a smaller percentage of farmers engaged in cassava cultivation were females. This may be due to the nature of the work and the accessibility structure of land for production. Women in Ghana have very little access to land for crop production. This is also partly due to the labour-intensive nature of cassava production (Yuguda *et al.*, 2013; Awotide *et al.*, 2015).

Most of the farmers (81%) in the Eastern region were married and about 61% were Christians by religion. This was similar in the Brong-Ahafo Region where about 73% were married and about 59% were Christians. This finding is very similar to that of Yuguda et. al. (2013) which was carried out in Nigeria. Where most of the cassava farmers in that area were also married. Unlike religion, marital status was found to have an effect on the profit efficiency of the farmer. Such that a married farmer is expected to be efficient compared with a farmer who is single, divorced/separated or has lost his or her spouse.

Table 4. 1: Socioeconomic characteristics of respondents

Variable	Eastern Region Frequency (N= 150)	Brong Ahafo Region Frequency (N= 150)	Pooled Frequency (N= 300)
Gender			
Male	91(61)	98(65)	189(63)
Female	59(39)	52(35)	111(37)
Marital Status			
Single	12(8)	24(16)	36(12)
Married	121(81)	109(73)	230(77)
Separated	3(2)	5(3)	8(3)
Widowed	14(9)	12(8)	26(9)
Religion			
Christian	87(61)	84(59)	171(60)
Muslim	30(21)	25(17)	55(19)
Traditional	25(18)	34(24)	59(21)
Access to extension service			
Yes	70(49)	97(67)	167(58)
No	72(51)	47(33)	119(42)
FBO membership			
Yes	41(27)	17(11)	58(19)
No	109(73)	133(89)	242(81)
Access to credit			
Yes	55(37)	52(35)	103(36)
No	95(63)	98(65)	193(64)
Farm Size (Hectares)			
0 – 5	115(77)	98(65)	213(71)
≥ 5	35(23)	52(35)	87(29)
Annual Income (GHc)			
< 2500	72(48)	86(57)	158(53)
2501 – 5000	34(23)	23(15)	57(19)
5001 – 10,000	17(11)	19(13)	36(12)
> 10,000	27(18)	22(15)	49(16)

Source: Survey data, 2018 - (Percentages in parenthesis)

Besides, being a member of a farmers' organization can easily enable farmers to access quality and cheap agricultural inputs which can also improve profits and yield. As noted in Table 4.1, the majority of farmers do not belong to farmer organization. About 73% and 89% of cassava farmers in the Eastern and Brong-Ahafo regions respectively do not belong to any farmer organizations. On the average (pooled), only 19% of cassava farmers belong to farmer base-organization. With regard to the sharing of ideas and good practices, it can be said that only a few cassava farmers who are members of farmer groups benefited from the sharing of ideas and good practices. Kebede (2001) observed that information sharing in a group improves technological adoption through the interactions, easing of the acquisition and use of input limitations faced by decision-makers (farmers).

Access to capital offers a means for farmers to improve and expand their farms. It also determines how easy it is for a cassava farmer to adopt new practices and technologies in his business (Tijani *et al*., 2006). From the study, about 65% of cassava farmers from both regions do not have access to credit. The absence of a credit facility can therefore have a negative impact on profitability in the area of study. The study of Wozniak (1993) claims that loans increase net income through individual characteristics, fixed inputs and market conditions while the absence of credit lowers farmers' productivity by lowering the adoption of high yield varieties and the acquiring of information needed to enhance efficiency.

On average, 71% of farmers cultivate on less than 5 hectares of land. This could be because the lands which are allocated for farming activities are now being encroached and used for other non-farm activities. This has reduced the available land for farming and therefore the need for farmers to adopt efficient farming practices. With the advancement in production methods, optimal allocation of resources is expected.

Table 4. 2: Other respondents' socioeconomic characteristics

Variable	Eastern Region Mean	Brong Ahafo Region Mean	Pooled Mean
Age	47.95(11.54)	44.19(13.2)	46.1(12.5)
Household size	7.2(3.4)	5.9(3.2)	6.6(3.3)
Experience	13.9(3.8)	10.4(5.2)	12.1(4.6)

Source: Survey data, 2018 - (Standard Deviations in parenthesis)

In Table 4.2, an age mean of 46 years was recorded for respondents in both areas of study. Farmers in Eastern region on the average were 48 years while farmers in Brong Ahafo region recorded an average age of 44 years. This indicate that farmers who are engaged in cassava cultivation are in their energetic time of life which may couple with high level of profit efficiency.

There is no overemphasis on the importance of household size in production, in particular when farmers might get their labour from the family during the production season. The farmers' family sizes ranged from one (1) to twenty (20) in both regions. But on the average, for the Brong Ahafo and the Eastern regions, most farmers were of an average household size of six (6) and seven (7) respectively. The large household size established from the study shows that the family labour is available with large family sizes. The result recorded, is consistent with what Yuguda *et al.* (2013) found, that cassava farmers had higher households in Nigeria.

Greater proportion of farmers in both Regions were found to have had about 22 years of experience in cassava production. This is because cassava farming is one of the passed-on livelihood activities for members of the communities in the study area. This conforms to the finding of Oladeebo &

Oluwara (2012), where most households were engaged in farming activities and thereby building experience over the years. See Table 4.2.

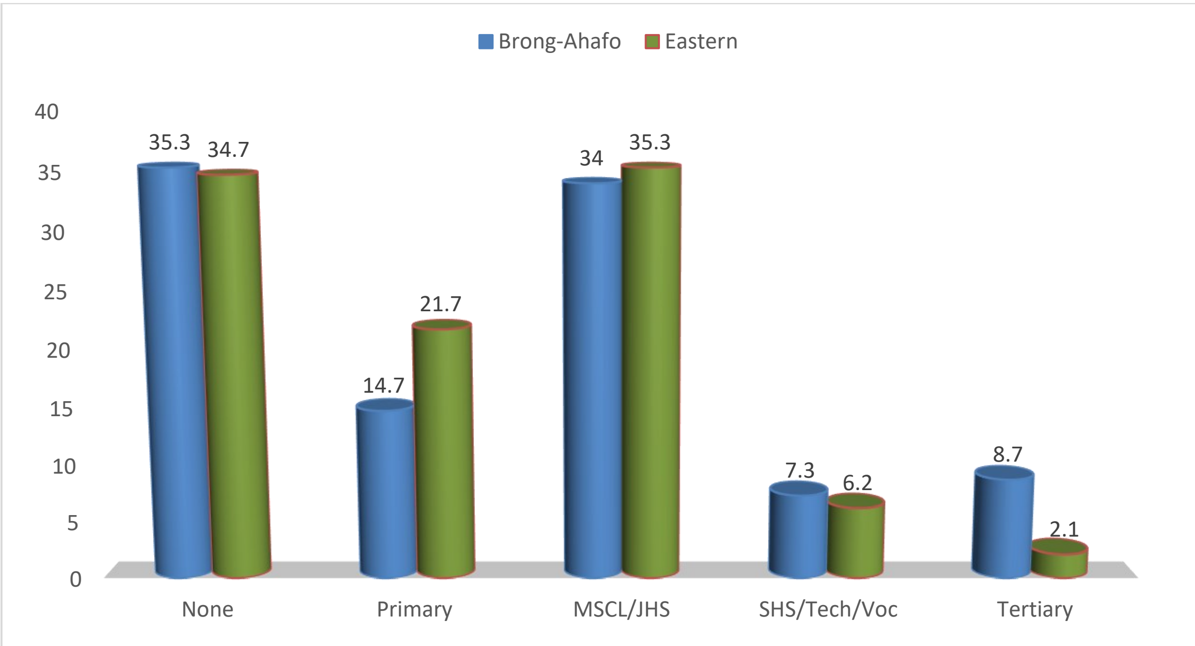

Figure 4. 1: Educational level of respondents
Source: Survey data (2018)

About 34% of the interviewed cassava farmers in the Eastern Region had no formal school education whereas in Brong Ahafo 35% of cassava farmers had no formal school education (See Figure 4.1). In the Eastern region, about 21%, 35%, 7% and 3% of the farmers interviewed had attended primary school education, JHS/MSCL, SHS/Technical and Tertiary level of education. Similar educational levels were recorded for farmers in the Brong-Ahafo region. On average, about 35% of cassava farmers in the study area had no formal education. Essentially, the majority (65%) of the farmers in the study area have obtained formal education at different levels. Education has a serious implication on the profit efficiency levels of farmers (Hyuha *et al*., 2007). The educational level of farmers influences the quality, quantities and speed at which farmers adopt and streamline inputs to increase production. The level of farmers' education influences agricultural production effectiveness. Education is human capital hence its impact on performance is expected to be positive (Tijani et al., 2006). The quality of work is being improved and new techniques are therefore being adopted by means of education (Tijani et al., 2006; Hyuha, 2006). In this way, cassava producers will adopt easily to new technologies that will improve their profitability in the study area.

4.3 Estimation of the cost and return levels of the farms in the study area

The estimated cost, returns and profit are represented in Tables 4.3, 4.4, 4.5 and 4.6. The table shows that the revenues made and the cost incurred in the two regions are not significantly different from each other.

Table 4. 3: Fixed Cost components for cassava farmers in the study area

	Brong Ahafo Region		Eastern Region		Pooled	
Variable	Mean (GHS)	Std. Dev.	Mean (GHS)	Std. Dev.	Mean (GHS)	Std. Dev.
Cutlass	62.30	54.08	53.42	53.86	57.78	54.05
Wheelbarrow	67.57	46.59	70.15	56.81	68.40	49.66
Hoe	51.83	44.76	39.98	36.69	45.88	41.25
Head pan	72.45	137.75	57.57	92.29	68.23	125.95
Boot	61.51	48.80	45.48	53.75	54.38	51.49
Basket/Bag	42.63	23.33	41.32	38.22	42.08	30.28
Water pump	146.76	131.10	16.25	12.52	112.72	126.37
Pickaxe	37.50	.	66.25	65.41	56.67	49.14
Harvester	300.00	70.71	126.67	193.48	196.00	170.24
Knapsack sprayer	86.19	65.03	85.28	74.23	85.77	69.03
Stem cutter	25.00	.	58.33	40.72	50.00	37.19

Source: Survey data, 2018

Table 4.3 shows the fixed cost items used in the calculation of the cassava producers' net income for the study area. The average sum for purchasing cutlass, wheel-barrow and hoe is GHS 54.86, GHS 68.40 and GHS 45.88. These are some of the main fixed inputs used by cassava farmers, although some growers may not use wheelbarrow. Atrill (2013) explained that there have been various increases in costs according to the type, techniques and inputs. Cassava farmers spend the least money on their fixed costs for the purchase of baskets/bags, stem cutters and boots. Their highest fixed cost item (GHS 196.00 and GHS 112.72 on average) is from the purchase of harvester and water pumps.

Table 4. 4: Variable Cost components for farmers in the study area

	Brong Ahafo Region		Eastern Region		Pooled	
Variable	Mean (GHS)	Std. Dev.	Mean (GHS)	Std. Dev.	Mean (GHS)	Std. Dev.
Total cost of planting materials	388.94	642.56	400.432	500.70	394.4588	577.78
Total cost of chemical	102.92	62.66	120.102	75.39	108.4172	69.801
Total cost of Fertilizer	98.2	20.53	112.50	35.85	108.5	25.44
Total cost of labor	1157.02	1046.60	1139.23	1005.72	1149.111	1026.39

Source: Survey data, 2018

An average of GHS 1157.02 was spent by the producer in terms of labour cost (both family and hired labour). In calculating for the amount spent on family labour, the opportunity cost of the producer working on another farm for wages instead of his/ her farm was used in the estimation process. The Labour cost was prominent in the total variable cost estimation. Cost of planting materials on the averaged was GHS 388.94. Cost of fertilizer and chemicals was GHS 98.2 and 102.92 for Brong Ahafo region whereas it was GHS 112.5 and 120.10 was found for Eastern region. See Table 4.4.

Table 4. 5: Cassava output components for farmers in the study area

	Brong Ahafo Region		Eastern Region		Pooled	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Quantity produced (MT)/Ha	33.83	26.06	32.48	26.72	33.16	26.35
Farmgate price (GHS/MT)	169.73	17.91	180.23	21.30	174.98	19.65

Source: Survey data, 2018

On the basis of the quantity of cassava output produced per hectare in the study area, about 34 MT was produced in Brong Ahafo region for the production year. Eastern region on the other hand produced about 32MT of cassava per hectare. On average (Table 4.5), about 33 MT of cassava per hectare was produced in the farming season. The average price for a metric ton was about GHS 175.00 in the study area for cassava.

Table 4. 6: Profitability analysis of cassava farmers

Variables / Hectare (Ha)	Brong Ahafo Region	Eastern Region	Pooled
Revenue (GHS)	6083.07	5820.37	5951.72
Operating cost (GHS)	1391.62	1199.89	1295.76
Depreciation (GHS)	224.91	149.99	198.72
NFI (Profit GHS)	4466.54	4470.49	4457.24
Capital Investment (GHS)	428.63	289.01	358.82
Return on Investment (ROI)	10.4205	15.46829	12.42194

Source: Survey data, 2018

The net farm income (profit) of cassava output per hectare at the farm level was positive. The return on investment and net farm income was calculated for cassava farmers in Brong Ahafo and Eastern regions. From Table 4.6, total revenue of GHS 6083.07 and 5820.37 was realized for

Brong Ahafo and Eastern regions for the growing season. On the average, the total costs (i.e. operating cost plus depreciation) incurred for Brong Ahafo was GH₵ 1616.53 per hectare while the total cost for Eastern was GHS 1439.88 per hectare. In outright terms, on the average, for cassava farmers in Brong Ahafo and Eastern region, GH₵ 5951.72 worth of profit was realized for the growing season. A total operating cost and fixed cost of GHS 1295.76 and GHS 198.72 (per Ha) were generated in the study area.

For further insights into the profitability of cassava farmers, return on investment (ROI) was computed. The estimated ROI for cassava farmers in Brong Ahafo and Eastern region were 10% and 15%. On average, the ROI recorded for the study was 12%. Economically, for every unit of capital invested by cassava farmers, farmers in the Eastern region yields a higher return on investment compared to their counterparts in the Brong Ahafo region. (See Table 4.6).

Differences in means of Revenue, Cost and Net farm income

The variation in the distribution of average cost, revenue and returns was assessed using a paired sample t-test. The significant difference or otherwise, between these means are shown in Table 4.7 for the two regions under study. Results from the computation of means revealed that there is inequity in the distribution of cost among farmers in Brong Ahafo and Eastern region. Whereas there is parity in the farmers' revenue and net farm income.

Table 4. 7: Differences in means of Revenue, Cost and Net farm income

	Mean	t-Stat	Pr (T > t)	Decision rule
Revenue				
Brong Ahafo Region	6083.07	0.464	0.3215	Failed to reject H0
Eastern Region	5820.37			
Total cost				
Brong Ahafo Region	1616.53	1.844	0.033	Reject H0
Eastern Region	1349.89			
Net farm income				
Brong Ahafo Region	4466.54	-0.0071	0.5028	Failed to reject H0
Eastern Region	4470.48			

Source: Survey data, 2018

This indicates that the difference in the mean revenue and NFI for cassava farmers in the two regions were not significant. this implies that the distribution of revenue and benefit was equal in the Brong Ahafo and Eastern region. Contrarily, cassava farmers in the Brong Ahafo region had the highest mean of cost and are significantly different from the mean cost for cassava farmers in the Eastern region. Results of the hypothesis tested are presented in Table 4.7.

4.4 Profit Efficiency Analysis

4.4.1 Hypothesis testing

Table 4.8 displays the effects of the different hypothesis tests for statistical adequacy and relevance of the data set. This is analyzed by using a generalized log-likelihood ratio test, of the specify stochastic frontier profit equation as well as the inefficiency models.

Following the result of the log-likelihood ratio (LR) from the Cobb-Douglas profit model, the study fails to reject the null hypothesis (see Table 4.8). The output from the Cobb Douglas profit frontier demonstrates a good model fit for estimation.

Table 4. 8: Hypotheses tests for statistical assumptions of stochastic frontier model

Hypothesis	Test statistic	Degree of freedom	Critical value	Decision
H_o: $\beta_{ij} = 0$	-6.631	10	23.21	Failed to reject H0
H_o: $\gamma = \delta_o = \delta_1 = \delta_2 = \ldots, = \delta_{13} = 0$	140.613	14	28.485	Reject Ho
H_o: $\gamma = 0$	7.41	1	5.412	Reject Ho
H_o: $\delta_1 = \delta_2 = \ldots \ldots, = \delta_{13} = 0$	123.841	13	27.69	Reject H0
H_o: δregion = 0	-.2614	1	6.63	Failed to reject H0

Source: Survey data, 2018

The hypothesis that in the profit-inefficiency model, the term "intercept" and coefficients linked to socio-economic and agricultural features (ineffectiveness effects are distributed half normal) is zero. The null assumption of farm inefficiency (Explanatory Variables / Characteristics) which does not affect farmers in the ineffective model is also rejected. This means that variables incorporated in the ineffective model jointly contribute significantly to the explanation of the impact of profits on the inefficiency of manioc farmers. The explanatory variables thus make a significant contribution to explaining profitability in the sampled producers in the profit inefficiency model. This means that the impact of these variables on the inefficiency of benefits is statistically significant. The last hypothesis was not rejected because there was no regional impact on profit efficiency. Therefore, the profit efficiency of cassava producers within the study areas is not affected by locations. This may be due to the mobile and efficient delivery to cassava producers by extension agents.

4.4.2 Maximum Likelihood Estimates of the Stochastic Profit Frontier model

This section presents the results of stochastic profit estimates. Assessment of frontier parameters and determinants of inefficiency are reported separately. Among the 17 parameters comprising the stochastic profit model, 12 were significant statistically. Furthermore, the sigma-squared value is significant in 1 percent, which suggests highly significant parameter estimates. The value of the (γ) parameter estimated at 0.884 was statistically significant and represented the ratio of the difference in inefficiency and difference in the error compound. This shows that inefficiency of an input mix is responsible for 88.4 percent of low output between cassava farms and their maximum benefit frontier. It can be said that differences in the farming practices and characteristics of sampled manhole farmers mainly reflect the observed variations in profit effectiveness between the manhole farmers.

Table 4.9 shows that except for the average price of agrochemicals, the Coefficient found from the estimation of normalized profit function on the basis of assumptions of output and competitive incomes was negative. The elasticity of agrochemicals was not anticipated to be positive. For all average prices, the expected signs were negative. The agrochemicals price did not comply with this forecast.

The coefficient for the average price of planting materials was negative and statistically significant at 1%. This happens to be a major factor in the determination of profit efficiency. This indicates that an increment in the prices of planting materials will result in 0.27% decrease in normalized profit of cassava production.

Table 4. 9: Maximum likelihood estimates of the stochastic profit frontier function

Variable	Parameter	Coefficient	Std. Err.
Price of Farm Tools	P_1	-0.063	0.0790
Price of Planting Materials	P_2	-0.199**	0.0820
Price of Agrochemicals	P_3	0.405***	0.0989
Price of Labour	P_4	-0.029	0.0867
Cons	α_1	7.941	0.4469
$\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$	γ	0.884***	
$\sigma^2 = \sigma_v^2 + \sigma_u^2$	δ^2	1.233***	
Log-likelihood		-324.672	
Number of Observation		300	

Source: Survey data, 2018 *, **, *** are10%, 5% and1% Significant Levels respectively.

However, the price of farm tools which was found to reduce (0.063%) the net farm income (profit) in cassava production is insignificant by the model in the study areas. This essentially means that if the average prices of farm inputs increase in the study area, it will not have any significant impact on the profit. Reasons are that most of these farmers are cultivating on small scale farms and hence use simple farm tools whose change in price will only have a small impact on the farming process.

The positive estimate for agrochemicals shows that using this input increases the output of cassava. The continuous cultivation of the same land over several years by cassava farmers in the study area has resulted in low fertility and health in most soils used, and hence the need to utilize agrochemicals. The study's estimated elasticity of indirect production implies that 1% increment in the amount spent on agrochemicals will result in 0.41% increment in cassava output (profit) since the application of agrochemicals greatly increases output thereby increasing profit.

The labour price measured in man-days (family and hired) had a negative, but not significant profit relation. This means that profit efficiency is reduced by the amount spent on work (man-days).

Table 4.9 shows a 1% increase in prices of labour (man-days) results in a decrease in cassava production and hence results in a decrease in profit of 0.03%.

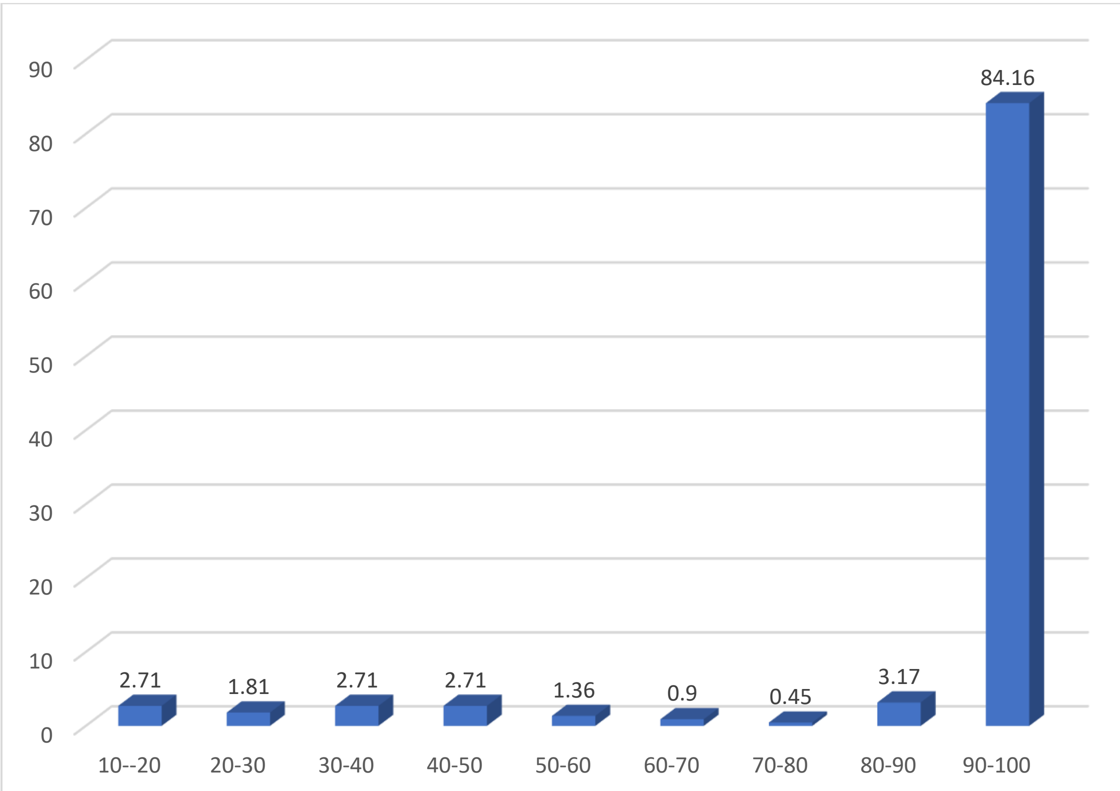

Figure 4. 2: Profit efficiency levels of the individual cassava farmers
Source: Survey data, 2018

The profit efficiency level of the individual cassava farmers is shown in Figure 4.2. About ten percent of the respondents had benefit effectiveness of less than 50% and about 6 percent profit efficiency of farmers is between 50% and 90% while about eighty-four percent of cassava farmers had profit efficiency above 90%. From Table 4.10, the average profit efficiency recorded for Eastern and Brong Ahafo regions is 85.86% and 92.7% respectively with a pooled profit efficiency mean of 89.62%. The profit efficiency average means farmers have been able to make around 89% of the possible profit expected from their input combination. That is approximately 11% of their profit is lost due to management inefficiency. There is therefore the scope to increase profit associated with cassava production in the short run. The profit efficiency result obtained in our work is better than Otitoju's (2011) findings that showed an average profit efficiency of 67% in Southwest Nigeria for crop farmers. Also, the outcome is more significant compared to the results by Iorlamen (2015), who detailed a profit efficacy average of 59 percent for the farmers.

Table 4. 10: Profit Efficiency of Cassava Farmers in the Study Area

	Profit Efficiency		
Region	Mean	Min	Max
Brong Ahafo Region	92.7	13.63	99.46
Eastern Region	85.86	10.10	99.3
Pooled	89.62	10.09	99.46

Source: Survey data, 2018

4.5 Determinants of profit efficiency of farmers in the study area

As presented in Table 4.11, some variables followed the expected signs in the estimated profit function. The findings emanating from this current study is in line with some previous works by Oladeebo & Oluwaranti (2012), Ogunniy (2008), Onumah & Essilfie(2020) and Kolawole (2006). In the explanation of the observed level, the indication of coefficient of these variables are very important. A negative sign suggests that the variable reduces profit efficiency, while a positive sign indicates an increase in profit efficiency. The results of inefficiency sources are shown in Table 4.11.

Results reveal the coefficient of gender, age, household size, experience, religion, education, training in cassava cultivation, contact with extension agents, access to capital and membership of farmer-based organizations are statistically significant. An increase in the percentage of the above variables indicates that it can increase or decrease the efficiency of the farmer’s profit depending on the sign attached to the coefficient.

Table 4. 11: Maximum likelihood estimates of profit inefficiency for cassava farmers

Variables	Coef.	Std. Err.	z
Region	-0.299	0.3225	-0.930
Gender	-0.842***	0.3184	-2.640
Age	-0.145***	0.0352	-4.120
Household size	-0.328***	0.0508	-6.460
Experience	0.142***	0.0322	4.420
Religion	0.514***	0.1772	2.900
Marital Status	-0.019	0.1235	-0.160
Education	-0.540***	0.1397	-3.870
Training on Cassava farming	0.570*	0.3152	1.810
Access to extension service	-0.518**	0.2044	-2.530
Access to Capital	1.177***	0.3323	3.540
FBO membership	-3.996***	0.9691	-4.120
Main occupation	0.664	0.4277	1.550
_cons	4.752***	0.9353	5.080

Source: Survey data, 2018

Gender has a statistically significant but negative coefficient. This implies that a male cassava producer is less profit inefficient in comparison to their female peer. This result is not surprising given the labor-intensive nature of cassava production. Male farmers are expected to be more profit efficient since they spend more time working in the cassava farm, and also being stronger and more energetic than females. This result can be explained by the distinct gender role played by women and men in cassava production. Men on account of their strength are mainly involved in land preparation activities (production aspect) as compared to women who are heavily involved in the value addition to cassava (processing aspect) in addition to some production activities such as planting and harvesting of cassava tubers (Lagat & Maina, 2017). UNDP (2012) also found that about 65%of women were involved in the production of cassava. This result does concur with the that of Onumah *et al.* (2010) and Onumah & Acquah (2011) that farming activities, when done by males, reduces inefficiency.

From the study, an increase in the age of farmers decreases the likelihood of profit inefficiency of the cassava farmers. This discovery supports the study of Adebayo *et al.* (2020) that suggested that advancement in age increases efficiency but contrary to the finding of Onumah & Acquah(2011). However, increasing age may translate to increasing more farming experience which accommodates using productivity enhancing agricultural practices. Although increase in age is proportional to experience, most of these farmers of the case study do not adopt the use of improved technology and productivity enhancing resources which increases their output and hence profits.

Additional members of a household were found to reduce profit inefficiency. The implication of this is that larger households tend to be more proficient compared to those with smaller sizes. This is in consonance with Bhatt & Bhat (2014) which found that increase in household size lead to increase availability of family labor and enhanced efficiency, especially in a labor-intensive agricultural system. However, other researcher found a contradicting result; Omidiye, 1988; Ogunniyi *et al.,* 2017 where they were of the view that larger household size is usually not a guarantee for increase in productivity, but associated financial upkeep burden of a large family may reduce financial commitment to efficiency-enhancing resources and practices.

Having some level of education by farmers positively influences profit efficiency of production of cassava. Having primary, MSCL/JHS, SHS/Technical or tertiary educational level imply increase profit efficiency. Probably due to the ability to understand and use improved technology and combine efficiently the available resources (production activities) to increase profit. The positive coefficient of level of educational is consistent with Ali & Flin (1989), Kumbhakar & Bhattacharya (1992), Huffman (1974) , Abdulail & Huffman (1988) and Kolawole (2006) indicating that education reduces profit inefficiency.

Engaging in cassava farming as the main occupation decreases profit inefficiency. This result implies that households with farming as their primary occupation have higher efficiency than other wise. In the case of cassava farming, farmer would have to actively be involved in all activities relating to the farming process since farmers are constrained with short raining season duration. In so doing, farmers who are engaged in cassava farming as their primary activity end up increasing their profit efficiency compared to their other counterparts. This result disagrees with Bhatt & Bhat (2014) and Ogundipe *et al.* (2019). They explained that households engaging in other non-farm occupation as primary occupation may have a more guaranteed source of income that could be ploughed into farming.

Farmers' membership in any farm group has a negative and statistically significant coefficient on profit inefficiency. In other words, cassava farmers who have joined farmers' groups or other associations or cooperatives are more efficient in terms of profit than their counterparts who belong to no groups. This result can be attributed to the sharing of ideas and information on best cassava production methods among members of the group, the opportunity for cassava producers to attend workshops, seminars and other educative events. These increase their capacity and productivity in the technological, allocative and managing sectors of their farming activities, thereby improving their efficiency. The results from Galawat & Yabe (2012), Muchhtar (2012) and Idiong (2007) are similar to this study.

The estimated coefficient of contact with additional service is also significant statistically, meaning cassava farmers' access/contact to extension service providers helps reduce cassava farmers' profit inefficiency. It is the highest coefficient recorded in the study and this make access to extension service by cassava farmers a very important variable. The utilization of extension services such as consultancy services and the education of the cassava farmers improves the farmers' capacity to adopt and make efficient use of productive resources. This finding is consistent with Ogunniyi (2011) and Alhassan (2008) who stated that access to extension services improves farmers' technology adoption and thus improving farmers' ability to operate more efficiently. The limited contact between extension service providers and cassava farmers and the misunderstandings of farmer's use of technology have resulted in disparities in the profit efficiency of cassava farmers.

4.6 The major constraints affecting cassava production

The constraints facing cassava farmers in their production were identified from the literature, pretested to include other constraints peculiar to farmers in the study area, after which it was presented to the farmers to rank. Farmers' most crucial constraints were assigned 1 and the least crucial constraints assigned 9. The results are presented in Table 4.12. Kendall's Coefficient of Concordance as shown in Table 4.12 is significant with asymptotic significance. The Kendall's Coefficient of Concordance (Wa), testing the null hypothesis that there's no understanding among the cassava farmers with regards to the constraints that prevent them from achieving the highest profit is also presented in Table 4.12. The null hypothesis was rejected at a 1% significance level in favour of the alternate. Moreover, Kendall's coefficient of 0.734 shows that about 73% of the farmers agreed to the ranking in Table 4.12. These limitations reported by the respondents are crucial therefore, in order to improve the production of cassava, consideration of proper measures is needed.

The major constraints to cassava production are; inadequate capital, lack of land for cultivation, poor marketing price, lack of improve planting materials, high cost of tractor services, post-harvest loss, high transportation cost, lack of technical assistance and lack of government support.

Table 4. 12: Constraints of the Cassava Farmers

Constraints	Mean Rank	Ranks
Inadequate capital	1.62	1st
Lack of Land for Cultivation	2.52	2nd
Poor Market/price	3.71	3rd
Lack of improve planting stakes	4.19	4th
High cost of tractor services	5.51	5th
Post-harvest loss	5.53	6th
High transportation cost	5.76	7th
Lack of technical assistance	7.71	8th
Lack of government support and policy	8.45	9th
Number of observations	300	
Kendall's Wa	0.734	
Chi-Square	1661.91	
Df	8	
Asymp. Sig.	0.000	

Source: Survey data, 2018

The results of the ranking are given in Table 4.12 with inadequate credit having the least mean score which signifies that it is the most pressing constraint farmers encounters in the region. This phenomenon is due to the risky nature of agriculture and specifically with cassava production. Banks find it difficult giving out loans to small-scale farmers in most cases. Okpukpara (2010) noted lack of credit to be one of the most pressing constraints facing cassava farmers.

Lack of land for production which is a well-known constraint especially in cassava production was ranked as the second most pressing constraint in the study area. Over the years, lands for agricultural production have been encroached and used for other non-agricultural activities. This has led to the reduction in the available land and some cases no land for cassava production. Leading to Anang *et al.* (2013) findings on a study.

The poor market price for cassava is ranked third among the constraints facing farmers in the study area. Low market prices pose a great challenge to farmers since comparably, the price per ton for cassava is very low. Lack of improved planting material was the fourth on the ranking scale. Accomplishing improved harvests commences with the choice of highly-efficient and high yielding planting materials and embracing appropriate planting techniques and so inadequacy of improved planting materials being ranked high by the farmers needs immediate attention.

Another constraint cassava farmers encounter in the study area is a post-harvest loss. Most farmers attributed the high post-harvest loss to pest infestation (including mealybug species, mites and whiteflies), bad storage facilities for cassava and high temperature. Most of these post-harvest losses, if not checked, seem probable to induce key degenerations in profit and thus drops in the livelihoods of countless underprivileged farmers. Subsequent constraints such as high transportation cost, high cost of tractor services and scarcity of technical assistance were also ranked 5th, 7th and 8th with mean ranks of 5.51, 5.76 and 7.71 respectively.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusion and policy recommendations based on the findings of this study. Policymakers can refer to this study for strategic planning and policy formation purposes.

5.2 Summary and Major Findings

The study was conducted in the Brong Ahafo (currently Bono and Ahafo Regions) and Eastern Regions of Ghana. A well-structured questionnaire was used to interview a total of 300 cassava farmers. The main objective is the estimate the profit efficiency of cassava growers in Eastern and Brong Ahafo Region of Ghana is. Out of which four specific objectives were developed. The first objective was an estimation of cost and return levels of farms in study areas. The second objective was to assess the profitability of individual cassava farmers. The third objective was to assess the factors that determine the effectiveness of farmers' profit in the study area and ultimately to identify and rank the main constraints of the farmers.

The study presented information on the personal and household characteristics of farmers, farm characteristics, profit structure, a ranking of constraints and determinants of profit efficiency. Specific determination of the profit level of cassava by means of the Net farm income (NFI) was used to achieve this. A maximum probability estimate combining the inefficiencies was used to determine the inefficiency of the cassava producers' earnings using a stochastic frontier model.

FRONTIER 4.1 software was used for the analysis. Kendall's Coefficient of Concordance was used to rank the constraints that come with cassava production. SPSS version 24 software was employed to rank the constraints.

The study revealed the dominance of males, married, Christians and adult farmers with an average age of 46 years old. The household size as recorded from the study area is between five and seven persons. Moreover, the majority of farmers in both study areas earns a monthly farm income of less than GHS 2500 and they have farming experience of about ten (10) years. Their farm sizes were averagely less than five hectares. Furthermore, majority of the farmers within the study area had attained some of formal education. Even so, a little over 30 percent of the farmers in the Eastern and Brong Ahafo Regions had no formal.

The study also revealed that the average profit a farmer makes in the growing season is GHS 4,457. The average farmer incurs GHS 1,394 as the cost for cassava production even though there is a significant difference in average variable cost incurred in the two regions. However, there is no significant difference between the revenue (GHS 5,951) generated in these Regions. The cassava farmers make a return on investment of about 12%.

The study again shows that cassava producers perform below the profit threshold and this is due to the presence of incompetence (γ =0.884) of cassava farmers. The mean profit efficiency of 0.89 implies that farmers obtained 89% of their profit from their unit mix of input. This also indicates that cassava farmers are not operating on a profitable frontier, and suggests that there is a high possibility that existing technology (harvesting), pest control and resources available to producers should be able to increase cassava production. Increment of profit is possible by 11% through allocative and technical efficiencies. About 11% of the profit is lost to the inefficiency of management.

Results also show farmers' profit inefficiency was influenced by educational level, farming experience, FBO membership, age, gender and marital status. Whiles planting materials and use of agrochemicals significantly profit of cassava farmers.

The main constraints by which cassava farmers are faced include; inadequate capital, lack of land for cultivation, inadequate working capital, government support and integrated market price. This means that cassava production will increase in the study area as land available for farming and working capital increases. The producers' rankings also showed that lack of government support and policy, lack of technical assistance, post-harvest losses, high tractor service costs and transportation costs are at least five immediate restrictions on the production of cassava in the study area.

5.3 Conclusion

Based on the results of the study, the following conclusions are made;

Cassava production is dominated by middle-aged experienced farmers. Farmers in the two regions under study have a positive value for their returns (ie. every farmer's return on investment was positive). Cassava can therefore be used as a tool for income generation for farmers. Net Farm Income (NFI) and Return on Investment (ROI) are significantly positive and different from zero. This shows that cassava cultivation is a very profitable business enterprise in the study area.

Result of the study has evidently demonstrated that engaging the Cobb-Douglas stochastic profit frontier enables in-depth scrutiny of the determining factors of specific farm efficiency.

In terms of profit earned from cassava farming, farmers are 86 percent profit efficient. The profit of the cassava farmer is significantly affected by the price of planting materials and the price of agrochemicals.

Experience, educational level, membership of a farmer in a farmer group/organization, age, gender and marital status significantly contribute to farmer's inefficiency in carrying out production activities on the farm.

Inadequate capital, lack of farmland, poor pricing and lack of support from the government are the major constraints militating against the success of cassava production.

5.4 Policy Recommendations

Following the results of the study, below are the recommendation proposed by the researcher. Cassava production can serve as employment to the youth since the sector is very profitable. The government should therefore intensify support for the youth to venture into the sector. This can be either be through the supply of inputs or initial startup capital for cassava production.

Improved and high yielding cassava variety with minimum pricing ought to be created by relevant research institutes and made available to farmers so as to raise the current yield of cassava per unit land area and increase the farmers' profit.

Arrangements that would increase access to machinery (tractor service), productive inputs (land), infrastructure (storage facilities) and marketing facilities should also be pursued by the government to improve the competitiveness of cassava products and increase profit efficiency of cassava production.

Also, agricultural extension services in Ghana needs to be improved to provide efficient and effective technical assistance/services to farmers to enable them to become more efficient in cassava production hence profit efficient. This is dependent on the conscious and deliberate investment in improving the capacity of the extension officers on modern technological agrarian innovations as well as dissemination of strategies so that they will be more beneficial to farmers.

Lastly, it also suggests that more workshops and training programs in a highly decentralized structure concerning cassava production be organized by Ministry of Food and Agriculture and other industry stakeholders from time to time such that cassava producer`s skillset will be enhanced and thus be more profit efficient.

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APPENDIX 1: QUESTIONNAIRE

UNIVERSITY OF GHANA, LEGON
DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS
PROFIT EFFICIENCY OF CASSAVA PRODUCTION IN EASTERN AND BRONG AHAFO REGION OF GHANA
QUESTIONAIRE

This research is for academic purpose. We would be very grateful if you could furnish us with all the necessary answers to the questions stated below. All information provided will be treated strictly confidential and will only be used for study purposes. Thank you.

Serial Number [| |]

Introduction

Name of Enumerator…………………………………..Date of interview……………./………../………….

Region: 01=Eastern Region [ ] 02=Brong Ahafo Region [ ]

District…………………………………………

Community / Village / Town:……………………………………………………………………………….…

Name of Cassava farmer:……

Name of Cassava Farm (if any):……..

Telephone number [| | | | | | | | |]

SECTION A: Socioe

Q1. Gender of Cassava Farmer: 01 = Male [ ] 02 = Female [ ]

Q2. Age of the farmer………………………………years

Q3. Marital Status: 01 = Single [ ] 02 = Married [ ] 03 = Divorced [ ] 04 = Separated [ ] 05Widowed [ ]

Q4. Religion: 01 = Christian [ ] 02 = Muslim [ ] 03 = Traditionalist [ ] 04 = Others (specify)……………………………………..

Q5. What is your level of education: 01 = No schooling [ ] 02 = Primary School [ ] 03 = MSCL/ JHS [ ] 04 = SHS/ Technical /Vocational [ ]
05 = Tertiary [ ] 06 = Others (Specify)………………………………….

Q6. Number of years spent to attain that Q5 level of education……………………….. years.

Q7. What is the size of your household (No. that eat from the same pot) ………………………….. person(s).

(a) Adults Males ………………… person(s). (b) Adult Females……………………….. person (s) (c) Children (<18)……………..person(s)

SECTION B: Basic information on Cassava Farming

Serial Number:

Q8. How long have you been in the Cassava farming business? …………………………….. year (s)

Q9. Have you ever had any cassava farming training before? 01 = Yes [ ] 02 = No [ ]

Q10. Has any family member had any cassava farming training before? 01 = Yes [ ] 02 = No [ ]

Q11. Have your hired laborers had any cassava farming training? 01 = Yes [ ] 02 = No [ ]

Q12. Is Cassava farming your major occupation? 01 = Yes [ ] 02 = No [ ]

Q13. If No to Q12, which of the following is your major occupation: 01 = Trading [ ] 02 = Salary Worker [ ] 03 = Artisan [ ] 04 =

Q13 Others (Specify)……………………………………………………

Q14. Did you ever have any contact with extension agents in the 2015 production seasons? 01 = Yes [ ] 02 = No [ ]

Q15. If Yes to Q14, how many times did you have contact with the extension agent in 2015? …………………………. times

Q16. How do you consider the extension service provided by the extension agent? 01 = Very Good [ ] 02 = Good [ ] 03 = Poor [ ]

04 = Very Poor [ ]

Q17. What kind of information did you receive from the extension agent? 01 = Production information [ ] 02 = Marketing Information [ ]

03 = Others [ ] Specify……….

Q18. Did you have access to capital/cash credit (or loan) in the 2015 production season? 01 = Yes [ ] 02 No [ ]

Q19. If No to Q18 specify why you did not apply for the credit?.....................................

Q20. If No to Q18 what was the source of capital (Credit) for your production activities? 01 = Personal Savings [ ] 02 = Earning from Properties [ ]

03 = Donation (Family/Relatives/Friends) [ ] 04 = Others [ ], Specify……….

Q21. If Yes to Q18, then which of the following sources did you get your capital (credit) for your production activities? 01 = Banks [ ]

02 = Money Lenders [ ] 03 = Family/Relatives [ ] 04 = Friends [ ] 05 = Local Co-operatives [ ] 06 = Others [ ], Specify………

Q22. Is it difficult for you to access the credit? 01 = Yes [ ] 02 = No [ ]

Q23. Did you receive the required amount, at the required production time? 01 = Yes [ ] 02 = No [ ]

Q24. How much did you receive? (GHc)……… (b) At what interest rate?.......... per month

Q25. Do you belong to any Association / Cooperative/Farmer Based Organization? 01 = Yes [ ] 02 No [ ]

Q26. If yes to Q25, what is the name of the Association / Cooperative/Farmer Based Organization?...

Q27. If Yes to Q25, state the nature of service(s) the FBO renders……………………………………………………………………………………..

Q28. Did the service(s) of the FBO enhance your production? 01 = Yes [ ] 02 = No [ ]

Q29. How many months did it take the Cassava from time of planting to harvesting?...Months

Q30. Are you aware of any improve Cassava variety as well as improved cassava land Cultivation Technology? 01 = Yes [ ] 02 No [ ]

Q31. If Yes to Q30 which type of improved cassava land cultivation technology do you know? …………………………………
Q32. Which type of cassava cultivation method do you use?.01 = Traditional [ ] 02 = New Technology [ ]
Q33. Which of the method in Q30 is profitable? 01 [ ] 02 [ ]

SECTION C: Production Information on input used.
Land Requirement
Q34. Land ownership 01 = Purchase [ ] 02 = Lease (rental) [ ] 03 = Share production [ ] 04 =Government [ ] 05 = Others (Specify)…………………………………………………………………………………………
Q35. If Lease (rental) from Q34 how much did you pay as the rental cost of the land annually (GH¢)……………… Size………………………..
Q36. If purchase from Q34, How much did you buy the land (GH¢)……………………size………………………..
Q37. If Share production from Q34, please, indicate the type of the agreement 01 = Ebunu [ ] 02 Ebusa [ ] 03 Others (Specify)………………………
Q38. If Government from Q34, please how much would you have paid as rental cost for the same piece of land? (GH¢)……………………. Size…………
Q39. Ownership of the Cassava farm: 01 = Solely owned [ ] 02 = Family 03 = Group owned [ ] 04 = Other (Specify)…………………
Material Requirement
Q40. What is the size of your farm?.......................
Q41. What is your source of planting stakes? 01 = Government institution [ ] 02 = Private institution [ ] 03 Others (Specify)……………..
Q42. Type of cultural system: 01 Monoculture [ ] 02 Multiple culture

Variable cost items
Q43. Please indicate the total stock of planting stakes (Bundles) in 2015

Type of Planting Stake	**Total Stock (2014)**	**(a) Total Quantity Used in 2014 (Bundle)**	**(b) Cost per Bundle**	**(c) Transportation Cost/Bundle**	**(d) Total Amount** ***d = a (b + c)***
CRI – Lamasese					
CRI – Abrabopa					
AGRA – Bankye					
CRI - Amansan Bankye					
CRI -Duade Kpakpa					
CRI – Dudzi					
Others (Specify)					

Q44. Do you use agrochemical for cultivation? 01 = Yes [ ] 02 No [ ]

Type of Agrochemical	Total Quantity used in 2015	Unit Cost	Total Amount

Q45. Do you use fertilizer for your cultivation? 01 = Yes [ ] 02 = No [ ]
Q46. Please indicate the quantity, unit cost and total cost of fertilizer used in 2015

Type of Fertilizer	Total Quantity (Kg) used in 2015	Unit cost	Total Amount
NPK			
Urea			
Organic Manure			
Others (specify)			

Labor Requirement
Q47. Source of Labor for cassava production? 01 = Family [ ] 02 = Hired Labor [ ] 03 = Both Family and Hired [ ] 04 = Others [ ] specify…………………
Q48. Is hired labor available for cassava production? 01 = Yes [ ] 02 = No [ ]
Q49. Which type of labor is available? 01 = Skilled [ ] 02 = Unskilled [ ] 03 = Others(Specify)………………………………………

Type	No. of Worker(s)		Hours in a Day	Cost per Hour GH¢	No. of Days in a Week	Total Hours	Total Amount in a month
	Male	Female					
Hired Labor							
Family Labor							
Children(s)/Child							
Family and Hired							

Q50. How much do you spend on in 2015? (GH¢)...
Q51. Do you have any difficulty in engaging the services of aggregators? 01 Yes [ ] 02 = No [ ]
Q52. Do Government minimum wage have any impact on hired labor for cassava production? 01 = Yes [ ] 02 = No [ ]
Q53. Please indicate quantity, year of purchase, cost price life span, depreciated value and share of cassava production

Output
Q54. What is the level of yield in the 2015 production season? 01 = Low [ ] 02 = Average [ ] 03 = High [ ]
Q55. What is the average quantity of Cassava harvested in 2015? ……………… tons
Q56. What is the quantity and cost for post-harvest lose in 2015? (i) Quantity ……… tons (ii) Cost (GH¢) …………….

Q57. What is the farm gate price of the product? (GHc)………………………………………………
Q58. Does climate change have any negative impact on cassava production? 01 = Yes [ ] 02 = No [ ]
Q59. Is there any Government policy on cassava production which creates ready market for the product? 01 = Yes [ ] 02 = No [ ]

Fixed cost items
Q60. Please indicate quantity, year of purchase, cost price life span, depreciated value and share of cassava production

Item	**Quantity**	**Year of purchase**	**Cost price GHc**	**Life Span (Year)**	**Depreciated Value**	**Share of Cassava Production**
Rent						
Tractor						
Cutlass						
Wheelbarrow						
Hoe						
Head pan						
Boot						
Basket/bags						
Water pump						
Pick up						
Harvester						
Other(s)						

SECTION D: Revenue/Benefits information
Q61. Revenue from the sale of Cassava in 2015

Variety	Total output/Quantity	Farm gate price (Unit)	Total

SECTION E: Constraints
Q62. Please tick where applicable and rank in order of decreasing severity the constraints you face in cassava production

Constraint	**Please tick (if applicable)**	**Position (rank 1, 2….9 with 1 = most severe and 9 = less severe)**
Lack of land for cultivation		
Inadequate capital		
Lack of government support and policy		

Lack of technical assistance		
Lack of improve planting stakes		
High cost of tractor services		
Post-harvest loss		
Poor market price		
High transportation cost		

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