KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

FACULTY OF AGRICULTURE

DEPARTMENT OF AGRICULTURAL ECONOMICS, AGRIBUSINESS AND EXTENSION

# ECONOMIC ANALYSIS OF COCOYAM PRODUCTION IN GHANA

BY

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**ECONOMIC ANALYSIS OF COCOYAM PRODUCTION IN GHANA**



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**A THESIS IS SUBMITTED TO THE KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FUFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF**

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## DECLARATION

I, STANLEY BOAKYE-ACHAMPONG, author of this thesis entitled "**ECONOMIC ANALYSIS OF COCOYAM PRODUCTION IN GHANA**" do hereby declare that to the best of my knowledge, the thesis is the product of my own original research work in the Department of Agricultural Economics, Agribusiness and Extension, College of Agriculture and Natural Resources-KNUST from August, 2013 to July, 2015 except for the references cited, which are duly acknowledged. This thesis is not published or submitted either in part or in whole anywhere for the award of any degree. I therefore, cede copyright of the dissertation in favour of the Kwame Nkrumah University of Science and Technology.

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## DEDICATION

This work is dedicated to the Achampong's Family; first and foremost to my mother, Mayfred Bemah Kwakye, for her spiritual, moral and motherly support throughout the period of study. You have indeed been such an influence and inspiration to me in my academic pursuit. I also dedicate it to my father, Kofi Boakye-Achampong and younger brother, Frederick Owusu Achampong.

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"*Never, never, never give up*" –Winston Churchill

*"We must study the present in the light of the past for the purposes of the future"* John Maynard Keynes

# ABSTRACT

Cocoyam is an important food security crop in Ghana because it stores better than the other root and tuber crops; however its production remains low. This study examines the economics of cocoyam production in Ghana. Using a multi-stage sampling technique, 150 cocoyam producers were drawn from Asante-Akyem South, Asunafo North and Fanteakwa districts in Ghana. Primary data, collected through questionnaire administration, was used to fit a CobbDouglas production function by employing the Stochastic Frontier Approach (SFA). Krippendorff's Alpha Reliability Test was employed to examine constraints faced in cocoyam production. Results from the study showed that cocoyam was predominantly cultivated as an intercrop (84%) with plantain, cocoa, and cassava. However, about 20% of producers in Fanteakwa and Asunafo North districts planted cocoyam as pure stand (sole cropping). Cocoyam was cultivated equally for sale and household consumption with corms being the main economic part even though producers also harvested cocoyam leaves for sale. The average land area under cocoyam cultivation was 0.55 hectares, corm yield was estimated at 6.5mt/ha and cocoyam leaves yield was about 0.59mt/ha. Cocoyam yield under mono-cropping system was found to be significantly higher than yield under intercropping system. Empirical results showed that labour, land area cultivated, quantity of planting materials (corm setts) planted and amount invested in other farm inputs positively influenced cocoyam production. Furthermore, the type of cropping system practised, extension contact, education, farming experience and household size had significant positive effect on corm production. However, the quantity of cocoyam leaves harvested from the crop, herbicide application and continuous cultivation on the same piece of land had significant negative effect on corm production. Labour constituted the biggest cost component for cocoyam production. Cocoyam production returned an average gross margin of GH¢ 5164 and net farm profit of GH¢ 4824 per hectare representing 24% return on investment. This suggests that the enterprise may be relatively profitable than similar farm investments, however not so profitable compared to the present cost of capital (25%) in Ghana. Producers in Fanteakwa had comparative advantage over those in Asunafo North and Asante Akyem South with relatively higher returns to land as well as labour and management. Cultivating cocoyam as a sole crop was found to be more profitable than as an intercrop. With a Krippendorff Alpha statistic of 0.54, the study showed a moderate level of concordance among cocoyam producers with respect to production, marketing and socio-economic constraints facing them. Producers ranked socio-economic constraints as the most significant set of constraints hampering cocoyam production followed by marketing constraints and production constraints respectively. Among other things, the study recommended the adoption of mono-cropping system to improve cocoyam production in Ghana; which is possible only if producers have improved access to farmlands. In this regard, re-introduction of the regulated rotational strategy for using secondary forest lands for food crop production under the Modified Taungya System (MTS) is recommended to boost cocoyam production in the country. The study further recommended the formation of policies directed at improving producers' access to capital and other productive inputs, more participation from male farmers and an enhanced extension delivery system so as to increase cocoyam production in Ghana. Finally, the study recommended that cocoyam producers especially in Asante Akyem South and Asunafo North intensify usage of market inputs so as to maximize yield, enhance their competitiveness and increase farm profit.

# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAS | Asante Akyem South District |
| AN_D | Asunafo North District |
| DEA | Data Envelopment Analysis |
| CGIAR | Consultative Group for International Agricultural Research |
| F_D | Fanteakwa District |
| FAO | Food and Agricultural Organization |
| FASDEP | Food and Agricultural Sector Development Policy |
| GDP | Gross Domestic Product |
| GEPC | Ghana Export Promotion council |
| GoG | Government of Ghana |
| GPV | Gross Product Value |
| GROCETU | Ghana Root Crops and Tubers Exporters Union |
| GSS | Ghana Statistical Service |
| LR | Likelihood Ratio |
| MDG | Millennium Development Goals |
| MLE | Maximum Likelihood Estimate |
| MoFA | Ministry of Food and Agriculture |
| MTS | Modified Taungya System |
| NGO | Non-Governmental Organization |
| NRCRI | National Root Crops Research Institute |
| OLS | Ordinary Least Squares |
| ROI | Return on Investment |
| RTIMP | Root and Tuber Improvement and Marketing Programme |
| RTIP | Root and Tuber Improvement Programme |
| SFA | Stochastic Frontier Analysis |
| SRID | Statistics Research and Information Directorate |
| SSA | Sub-Saharan Africa |
| TR | Total Revenue |
| TVC | Total Variable Costs |
| WAAPP | West Africa Agricultural Productivity Programme |

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background Information

Agriculture primarily performs the role of provision of food, supply of raw resources for industry, employment creation and generation of foreign exchange through exports. Aside that, agriculture is recognised as a major sector of the economy which has a greater impact on poverty reduction relative to other sectors of the Ghanaian economy (FASDEP II, 2007). Root and tuber production has become one of the foremost sources of economic and household food security for many people in Ghana.

In Ghana, root and tuber crops contribute about 50 percent of the nation's agricultural GDP and these crops are grown by about 55 percent of Ghanaian farmers (MoFA, 2010). The commonest root and tuber crops cultivated in Ghana are cassava, yam, cocoyam and sweet potato. The per capita consumption of a Ghanaian consumer is estimated to be 151.4kg of cassava, 43.3kg of yam and 56kg of cocoyam. Root and tuber crops account for 58 percent of per capita food consumption thus, making the crops major sources dietary calories in Ghana (Sagoe, 2006).

Cocoyam (*Xanthosoma spp.*), also known as tannia, is a well-known food security crop due to its better storability compared to the other root and tuber crops (Onyeka, 2014). It is often cultivated by farmers as an intercrop with plantain, yam, cocoa, maize, banana, vegetables and rice (Quaye *et al.* 2010; Ikwelle *et al.* 2003). Most producers cultivate cocoyam as a vegetable root crop for both leaves and corms at subsistence level. Others cultivate the crop mainly for cash. The leaves and corms serve as good sources of plant-based vitamins and minerals (ascorbic acid, thiamine, riboflavin and niacin), proteins and easily digestible starch and significant amounts of dietary fiber (Onwuka, 2012). Apart from its primary benefits as food, Adelekan (2011) stated that cocoyam is also source of biofuels like ethanol and methane.

The root crop is also a foreign exchange earner for the country. In recent times, it is gradually receiving attention as a non-traditional export commodity. Since 2000, cocoyam exports have been on the increase with exports mostly directed at United Kingdom and other EU markets for West Africans living in the diaspora.

In 2000, Ghana earned US$54,400.00 from cocoyam exports and this increased by more than four times to US$211,690.00 in 2008 at a price value of US$778.00 per tonne according to the Ghana Export Promotion Council (GEPC). The relatively high export price value of cocoyam compared to other non-traditional export commodities like yam (US$714/tonne) and pineapple (US$337/tonne) indicates its potential as a major non-traditional export commodity for Ghana. (Onyeka, 2014; Acheampong *et al.*, 2014; Sam and Dapaah, 2009).

Ghana is currently the third highest producer of this crop after Nigeria and Cameroon in SubSaharan Africa and fourth highest producer in the world (FAOSTAT, 2014). Ghana produced about 1.2 million metric tonnes of corms in 2013. Cocoyam commands a higher price per tonne than most root and tuber crops, except yam. The root crop therefore provides several opportunities for generation of income and the attainment of food security because of its multiple uses and the consumption of its various products i.e. both leaves and corms (MOFASRID, 2014; Sagoe, 2006).

Cocoyam is most suitable and predominantly cultivated in transitional and forest zones of Ghana. The major producing areas are in the Eastern, Brong Ahafo, Ashanti and Western Regions of Ghana (Acheampong *et al.* 2014). Even though cocoyam has numerous socioeconomic and nutritional importance production levels continue to drop each year resulting in reverse growth and contraction of the cocoyam industry. Land areas under cultivation have consistently declined whereas current yield levels are below national achievable average of 8 mt/ha (MoFA, 2010).

## 1.2 Research Problem

Key among the recent sustainable development goals (SDG) is the goal to end hunger, achieve food security and improved nutrition as well as promoting sustainable agriculture by 2030 (UN, 2015). An effective agricultural system characterised by efficient production regimes, vibrant value addition and distribution networks as well as corresponding rewards to all stakeholders is one that will make SDG 2 a reality by 2030.

In order to achieve this goal, Ghana has taken keen interest in the performance of the root and tuber subsector vis-à-vis its enormous contributions towards poverty reduction and attainment of food security. Cocoyam is considered the third most important root and tuber crop in Ghana and it is a significant food security crop because it stores better than all other root and tuber crops. The root crop plays an important role in the livelihood of rural and urban dwellers because it is a major source of dietary calories and income especially in times of food shortage and economic stress (Onyeka, 2014; MoFA 2010; Quaye *et al.* 2010).

The cocoyam subsector (and root and tuber crops in general) has benefited from interventions by government and stakeholders by way of research, innovation and policy interventions in recent times so as to boost production in Ghana. Such policies and interventions have been directed at enhancing production through yield improvement programmes and improving the value chains through effective marketing. Notable among such programmes are the Root and Tuber Improvement Programme (RTIP); Root and Tuber Improvement and Marketing Programme (RTIMP) and the West Africa Agricultural Productivity Program (WAAPP) (Acheampong *et al.* 2014; RTIMP, 2014; Sam and Dapaah, 2009). Significant outcome of these interventions resulted in the release of three high yielding and early maturing cocoyam varieties for use by cocoyam producers (Domfeh, 2014).

In spite of these programmes and interventions coupled with the socioeconomic and nutritional importance of cocoyam, decline in cocoyam production persists and yield levels remain low. National production statistics show that between 1999 and 2012, cocoyam production has dropped by a significant 19.3 percent i.e. from 1.6 million metric tonnes to 1.27 million metric tonnes (MoFA-SRID, 2013; FAOSTAT, 2013; Quaye *et al.*, 2010). The average yield of cocoyam ranges between 6–6.5mt/ha and falls short of the estimated potential yield of 8mt/ha (MoFA, 2010). The current trend has resulted in supply deficits, stifled income and economic wellbeing of players in the cocoyam value chain and in the long run, food insecurity issues. Ijioma *et al.* (2014) states that the declining production has resulted in shortage of supply of cocoyam (corms and leaves) in the domestic market indicating serious implications for food security and farmers' income.

Several factors can be attributed to low cocoyam production. Prominent among these factors include lack of use of improved varieties, cropping culture, high labour requirement during cultivation methods resulting in high cost of production, continuous cropping on the same piece of land resulting in declining soil fertility.

Improved varieties are often high yielding and disease resistant. Cocoyam farmers predominantly use the landraces which invariably result in low per capita cocoyam production. Currently, three improved varieties of cocoyam have been developed through the WAAPP programme for use by cocoyam producers but the lack of use may be due to unavailability or these improved varieties in commercial quantities (Quaye *et al.*, 2010). Furthermore, cocoyam is predominantly cultivated as an intercrop with other cash and food crops. When intercropped, cocoyam is often not the main crop. Due to competition of space, nutrients and other factors of production from the intercrops, yield of cocoyam under this cropping culture can ultimately be reduced.

Continuous cropping on the same piece of land without fallowing or fertilization over a period of time ultimately results in poor soils which can affect yield. Cocoyam farmers often crop on the same piece of land continuously without any form of nutrient replenishment or fallowing (Onyeka, 2014). The issue of continuous cropping can be linked to scarcity or lack of access to agricultural land due to declining forest frontiers suitable for cocoyam as a result of aggravated forest degradation and climate change. Agricultural production in Ghana by default, has been boosted by increasing land under cultivation. Farm expansions have become very limited due to land scarcity and so existing agricultural lands are most likely being continuously cropped without fallowing or any form of fertilization.

Cocoyam cultivation often demands few external and minimal use of inputs such as fertilizer and agrochemicals. However the labour-intensive nature of production especially for activities like planting, weeding and harvesting activities translates into high production cost for producers. The cost of labour for cocoyam production alone constitutes over 50 percent of total cost (Quaye *et al.* 2010; Azeez and Madukwe, 2010). Employing farm labour is very expensive but because cocoyam production is dominated by rural poor and women farmers who have limited access to capital, adequate crop husbandry can often not be provided due to financial constraints.

This situation has also resulted in the over reliance on crude traditional methods of production such as the use of unimproved planting materials which affects their ability to increase yield and income. Talwana *et al.* (2009) noted increased involvement of producers in cocoyam production will largely depend on the returns of the enterprise.

Given the relative economic significance of cocoyam, the challenge of low production will most likely persist if a better understanding of the factors that affect cocoyam production are not investigated through empirical research. Currently, the actual effects of most of these variables affecting cocoyam production and its profitability are still in the realm of speculation since there exists very limited empirical evidence in Ghana regarding the critical factors that affect cocoyam production and the extent of influence of these factors. This study has therefore been conducted to analyse and understand underlying factors influencing cocoyam production, determine whether or not the cocoyam enterprise is profitable and to find out what production, marketing or socio-economic constraints cocoyam producers are facing. These evidences are required so as to guide future policy decisions

### 1.3 Research Questions

The following questions were addressed in the study;

1. What proportion of cultivated land is used for cocoyam production by producers in the study districts?
2. What is the current yield level recorded by cocoyam producers in different producing districts?
3. What factors influence the level of cocoyam production in the study districts?
4. Is the production of cocoyam financially profitable under different cropping systems and producing districts in Ghana?
5. What are the major production, marketing and socio-economic constraints faced by producers in different districts?

### 1.4 Research Objectives

The main objective of this study was to examine the determinants of cocoyam production and to evaluate the profit levels obtained by farmers in major producing districts in Ghana.

Specifically, the study seeks to;

1. To determine the proportion of cultivated land used for cocoyam production by producers in the study districts.
2. To estimate the output and current yield of cocoyam producers across different producing districts.
3. To determine the factors that influence the level of cocoyam production in the study districts.
4. To evaluate the profitability of cocoyam production under different cropping systems and producing districts in Ghana.
5. To examine the critical production, marketing and socio-economic constraints faced by cocoyam producers in different producing districts in Ghana.

## 1.5 Hypotheses

Table 1.1 provides the main hypotheses tested in the study and their sources.

**Table 1.1 Hypotheses tested**

| No. | HYPOTHESES | SOURCE |
|---|---|---|
| **1** | Area planted, quantity of planting materials used, labour, costs incurred on other inputs, farming experience, mono-cropping and extension contact have significant positive effect on cocoyam output. | Onyenweaku and Okoye (2007); Adepoju and Awodunmuyila (2008); Azeez and Madukwe (2010). |
| **2** | The use of chemical weedicides/herbicides and quantity of cocoyam leaves harvested have negative significant effect on cocoyam output. | Asumadu *et al.* (2011); Safo-Kantanka, (1988). |
| **3** | Cocoyam production is financially profitable in Ghana. However, the level of profitability differs significantly across producing districts. | Ekunwe *et al.* (2015); Quaye *et al.* (2010); Sagoe *et al.* (2007). |
| **4** | Cocoyam production under mono-cropping system is more productive and financially rewarding than under the mixed cropping system. | Sagoe *et al.* (2007) |

## 1.6 Justification

This study is timely given the current dynamics of the cocoyam sub-sector together with the fact that cocoyam is a major staple food that has a potential to remedy food insecurity in Ghana. Cocoyam is a staple crop in Ghana and has an average per capita consumption of 57.1kg (Quaye *et al*. 2010).

It is mostly produced and consumed by the rural poor and food insecure households and it is known to have better nutritional qualities than other root and tuber crops like yam and cassava (Onyeka, 2014). The crop is predominantly cultivated and traded by women therefore making it a significant source of employment and income for both rural and urban dwellers especially women. Cocoyam is also known to provide foreign exchange by way of export earnings and thus contribute to Ghana's socio-economic development.

Cultivation of the crop therefore, offers an alternative but important source of income and food security for especially its producers and rural Ghana which constitutes over 48 percent of the country's population (GSS, 2014). This role of cocoyam as a significant alternative food source is further entrenched by the recent fast transformation of cassava into an industrial and cash crop according to Shiyam *et al.* (2010), which directly has implications on food availability and supply in Ghana. This study, by looking at the policy variables that influence cocoyam production in Ghana with particular focus on the most important producing regions, seeks to contribute empirical evidence to the recent national discussion on improving cocoyam production and highlights the critical production, marketing and socio-economic constraints that cocoyam producers currently face. This is expected to ultimately be the basis for pragmatic policy decisions that will improve production, expand the cocoyam subsector through increased participation and to further strengthen the cocoyam value chain.

Unlike other traditional root and tuber crops e.g. yam and cassava, cocoyam has often been neglected in terms of research efforts in Ghana until recently. Quite a substantial amount of empirical research on cocoyam has been conducted in other SSA countries especially in Nigeria (world's major producer). A few of those studies include Ekunwe *et al.* (2015), Onyeka (2014), Eze (2014), Falola *et al.* (2014), Adelekan (2011), Amusa *et al.* (2011), Azeez and Madukwe (2010) and Adepoju and Awondunmuyila (2008). Very few of such empirical studies exist in the Ghanaian context. So far empirical studies like Asumadu *et al.* (2011), Quaye *et al.* 2010; Sagoe *et al.* (2007) and Sagoe (2006) have been conducted on cocoyam in Ghana. These studies only touched on profitability of cocoyam enterprise one way or the other but none of the studies provided empirical information on the determinants of cocoyam production in Ghana. The current study provides empirical information to bridge this knowledge gap.

Cocoyam producers are characteristically different due to varying socio-economic settings, scale of production, markets and producing regions. Previous empirical studies on cocoyam production either focussed only on one producing district e.g. Quaye *et al.* (2010) or ignored the possible variability of producing households across different categories by analysing only the pooled data e.g. Ekunwe *et al.* (2015). Aggregating data for producers on production issues in spite of important potential variabilities or focussing on just a segment of producers hides significant information which otherwise will answer the diversity of factors affecting production at various levels as well as the levels of profitability. In order to highlight and account for such possible differences, this study spans three major producing districts in the three most important cocoyam producing regions of Ghana. Analysis on areas under cocoyam cultivation, yield, determinants of production, profitability were each done at the district level, for the pooled sample and for different cropping systems i.e. sole and intercropping.

Cocoyam production in Ghana is faced with several constraints. In order to effectively address the issue of dwindling production of cocoyam in Ghana, proper constraints assessment needs to be carried out so as to help policy formulation. Previous studies either do not focus on constraints assessment at all e.g. Sagoe *et al.* (2007) and Asumadu *et al.* (2011) or seem to provide inadequate constraint assessment by not providing the statistical reliability of constraint rankings as in Acheampong *et al.* (2014) and Quaye *et al.* (2010). This study provides detailed assessment of production, marketing and socio-economic constraints affecting cocoyam producers in each district as well as the pooled. The study further tests the statistical reliability of the constraints using the Kripendorff‘s Alpha Reliability Test (KALPHA).

The basic thrust of the economics of agricultural production at the micro level is to assist farmers to attain their main objective which is profitability. Through this study, farmers and other stakeholders in the cocoyam value chain will identify the most important cost components in cocoyam production to be able to effectively manage them for improved profitability.

Again, determinants of production are very necessary in Ghana's quest to improve cocoyam production. This study will therefore identify the critical factors that drive cocoyam to guide policy makers in the formulation of appropriate policies and to guide the investment decisions of producers to ensure the growth of the cocoyam sub-sector.

## 1.7 Scope of the Study

Cocoyam is a common name for both *Xanthosoma spp*. (tannia) and *Colocasia esculenta* (taro). In Ghana, the commonest and most important cocoyam genus is *Xanthosoma spp* also called tannia and that is what this study basically focusses on. Unless otherwise specified, the use of cocoyam in this study therefore exclusively refers to *Xanthosoma spp.* locally known as 'mankani'. Cocoyam is commonly grown within the forest agro-ecological zone of Ghana. Specifically, the root crop is predominantly cultivated in Ashanti, Brong Ahafo, Western, Ashanti, Eastern, Volta and Central regions of Ghana (Acheampong *et al.* 2014).

This study is a cross-regional study that covered the most important producing regions i.e. Ashanti, Eastern and Brong Ahafo regions of Ghana. Furthermore, three districts well-known for cocoyam production within the regions were the main focus of this study i.e. Asunafo North, Fanteakwa and the Asante Akyem South districts of the Brong Ahafo, Eastern and Ashanti regions respectively.

In order to avoid inconsistencies and ensure high level of credibility of the data and results, respondents (farmers) were restricted to shorter recall period by providing information on the most recent production season which is 2014/2015 cropping season. This was considered because cocoyam is mostly harvested between 10-16 months after planting based on desired corm size or market conditions. The most recent production season was chosen not only for data credibility reasons. In understanding production issues, it was assumed that the most recent season is representative of a typical cropping regime for any cocoyam producer. The research focused only on cocoyam producers and the emphasis of this study was on land allocations for small-scale cocoyam production, factors that influence production; profitability of cocoyam production and constraints hampering cocoyam production.

## 1.8 Organization of the Study

This study has been organized into five chapters. Chapter one opens with the background of the study which is followed with problem statement and hypotheses and research questions arising from the statement of the problem. Chapter one also includes the study objectives followed by the justification, scope and organization of the study.

Chapter two contains a review of relevant literature on empirical works and theoretical foundations of the subject matter as well as the conceptual framework. This section was important in understanding the state of the art and knowledge gaps so as to be able to contribute to knowledge.

The third chapter contains the methodology employed in this study. Here, the choice of the study area and sampling procedure as well as the data collection method are all discussed. It also includes the empirical models that were employed in analysing the data obtained from the field. Chapter four deals with detailed analysis of the data obtained and discussion of the findings are done according to the objectives of the study. The study concludes with chapter five. This final chapter summarizes the major findings and conclusions and presents the main recommendations drawn out of the findings of the study.

## CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Introduction

This chapter takes a detailed look at diverse studies already conducted by other researchers with respect to determinants and profitability of agricultural or cocoyam production. The chapter briefly reviews the uses and nutritional benefits of cocoyam, production trends, the state of cocoyam production in Ghana as well as factors affecting agricultural production. Also, empirical studies and methodologies that have been employed in analysing determinants of production and profitability, as well as constraints analysis have been reviewed highlighting observed shortfalls and probable knowledge gaps which can be filled.

### 2.2 Cocoyam: Uses, nutritional value and health benefits

Cocoyam is an herbaceous plant which belongs to the family *Araceae*. It is usually cultivated for its edible roots, although other parts of the plant, especially its leaves, are used as human food. Inedible cocoyam species is also grown as ornamental plants (PlantVillage, 2014; AGRO-HUB, 2013). Cocoyam is the universal name for corm and tuber plants in the *Araceae* or Aroids family. The root and tuber crop belongs to either the genus *Colocasia* or the genus *Xanthosoma* and are generally comprised of large spherical corms (swollen underground storage stem), from which a few large leaves emerge (AGRO-HUB, 2013). Cocoyam is a general used to refer to *Xanthosomona* species also known as 'tannia or cocoyam' and *Colocasia* species also called 'taro or old cocoyam' in many parts of Africa (Onwuemme and Sinha, 1993).

Even though cocoyam encompasses different genera as has already been stated and other genera such as *Alocasia*, *Crytospema* and *Amorphophallus*, Onyeka (2014) states that in SubSaharan Africa, the two most extensively cultivated species are *Colocasia esculenta* and *Xanthosoma sagittifolium*. The leaf blades are large and heart-shaped and can reach 50 cm (15.8 inches) in length. The corm produces lateral buds which give rise to tubers or cormels and suckers or stolons. Cocoyam commonly reaches in excess of 1 m (3.3 ft) in height and although they are perennials, they are often grown as annuals, harvested after one season (PlantVillage, 2014).

Cocoyam is grown for food and plays very significant role in the livelihood of rural farmers, who often resort to cocoyam as an alternative source of their daily calories during periods of food scarcity (hunger gaps) and economic stress for most people in West Africa and the Pacific (Onyeka, 2014; Sam and Dapaah, 2009). The corms, cormels and leaves are eaten after roasting, boiling or baking. Meals, sauces and baking flours can also be prepared out of it. It can also be pounded, fried, milled or converted into other semi-processed end products for stabilizing (Owusu-Darko *et al*. 2014).

The starch from cocoyam is readily digestible, hence it is used to prepare baby food (by cutting corms into pieces, boiling and mashing). In Ghana, this soupy baby food and appetizer is known as 'mpotompoto'. Owusu-Darko *et al*. (2014) noted that the smaller starch granules of cocoyam is what has been associated with better digestibility over other starchy crops. The young fresh leaves locally known as 'kontomire' are used as vegetables after boiling in order to remove the acrid flavour (which causes irritation in the throat or mouth linings upon ingestion). Local sauces such as palaver sauce and *agushi* stew can be prepared with it. Cocoyam is used as a ready alternative to plantain and yam in making 'fufu' or 'ampesi' during the off-seasons of yam and plantain. It is also common in Ghana to find cocoyam chips which are deep-fried slices of the corms about 1 mm thick often prepared and sold as snack (OwusuDarko *et al*., 2014).

Cocoyam has other uses aside the commonly known traditional culinary uses. The flour can be used to bake bread and biscuits, prepare soups, beverages, and puddings according to OwusuDarko *et al*. (2014). Research has also shown that cocoyam starch can be modified into becoming an alternative to the other commonly used industrial starches (Lawal, 2004). Subhadhirasakul *et al*. (2001) reported that cocoyam starch can be used to effectively replace maize as a binding agent in the manufacture of tablet drugs. Onwulata and Konstance (2002) have also reported on the process of formulation of weaning food with taro flour extruded with whey protein concentrate, whey protein isolate and lactalbumin.

Cocoyam is considered the most nutritious compared to other root and tuber crops like yam and cassava. According to Onyeka (2014) cocoyam has nutritional values comparable to potato. A lot of nutrients are derived from the corms, cormels and leaves as well. OwusuDarko *et al.* (2014) noted that cocoyam contains 20 to 28 percent starch (carbohydrates) and 1.12 percent protein.

It also contains thiamine, riboflavin, and niacin as well as significant amounts of dietary fiber. Cocoyam also contains higher amounts of essential minerals like Mg, Ca. K and P than yam, cassava and plantain (Onyeka, 2014; Eleazu, 2013; Niba, 2003).

Cocoyam leaves are also a good source of vitamins A and C and contain about 20 percent protein on dry weight basis which is more than the amount of protein contained in the corms. Cocoyam leaves are highly recommended for diabetic patients, the aged, children with allergies and for other persons with gastro-intestinal disorders (Plucknett, 1970). A study by Eleazu *et al.* (2013) concluded that use of cocoyam flours in the dietary management of diabetes mellitus could be a breakthrough in the search for plants that could prevent the development of diabetic nephropathy. Table 2.1 provides a summary of the nutritional contents of cocoyam per 100g of edible portion.

**Table 2.1: Nutritional content of cocoyam per 100g edible portion**

| **Constituent Tannia (*Xanthosoma saggittifolium*) Major Nutrients Corms Leaves Shoots** | | | |
|---|---|---|---|
| Calories | 133 | 34 | 24 |
| Protein (g) | 2.0 | 2.5 | 0.5 |
| Fat (g) | 0.3 | 1.6 | 0.2 |
| Carbohydrates (g) | 31 | 5 | 6 |
| Fibre (g) | 1.0 | 2.1 | 0.9 |
| Calcium (mg) | 20 | 95 | 49 |
| Phosphorus (mg) | 47 | 388 | 25 |
| Iron (mg) | 1.0 | 2.0 | 0.9 |
| Vitamins | | | |
| $\beta$-carotene equiv ($\mu$g) | Trace | 3300 | - |
| Thiamine (mg) | 0.10 | - | - |
| Riboflavin (mg) | 0.03 | - | - |
| Niacin (mg) | 0.5 | - | - |
| Ascorbic acid (mg) | 10 | 37 | 82 |

Source: Opara (2003)

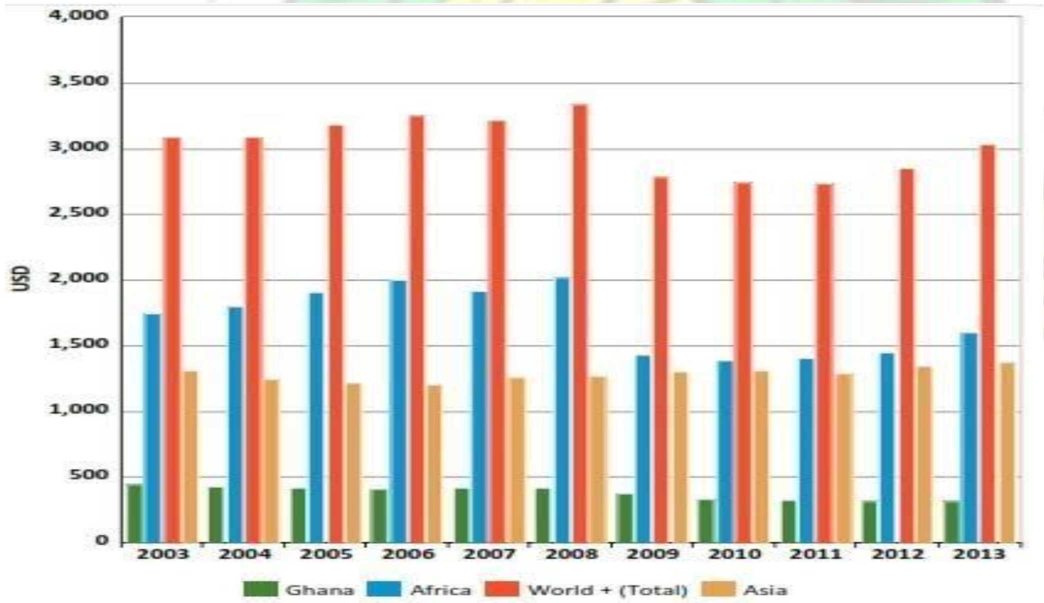
### 2.3 Production volumes and trends of cocoyam production

### 2.3.1 The World and African perspective

Sub-Saharan Africa (SSA), is by far the world's major producer of cocoyam according to the statistics from the Food and Agriculture Organization (FAOSTAT, 2014). Onyeka (2014) indicated that SSA alone accounted for 74 percent of total cocoyam production in the world between 2008 and 2013. In 1999, the FAO Database reports showed that about 6.6 million tonnes of cocoyam were produced worldwide on a total land area of 1.07 million hectares with the bulk of the production and area cultivated coming from Africa.

In 2013, the world produced 10.5 million tonnes of cocoyam which translates into a Gross Production Value of about US$ 3 billion. A total area of 1.4 million hectares was used for cocoyam cultivation in 2014 with an average yield of 7.5 metric tonnes per hectare. Nigeria is the world's largest producer of cocoyam, producing 3.9 million tonnes (40.5 percent of total production) in 2013. China, Cameroon and Ghana follow in order of importance producing 1.8 million (19.2 percent of total production), 1.6 million (16.1 percent of total production) and 1.3 million tonnes (13.1 percent of total production) of cocoyam respectively (FAOSTAT, 2014). In 2014, Africa accounted for 52 percent of the total taro (cocoyam) production in terms of Gross Production Value (Figure 2.1).

**Figure 2. 1: World cocoyam production - Gross Production Value- constant 2004-2006 million US$**

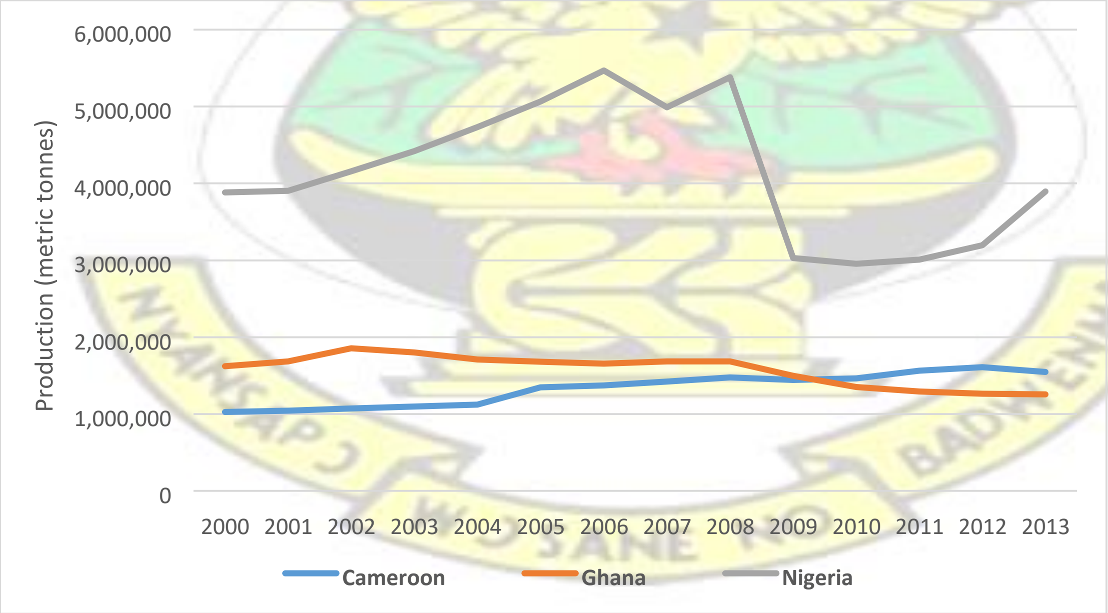



Source: FAOSTAT, (2014)

The Consultative Group for International Agricultural Research (CGIAR) report on cocoyam in 2014 indicated that from the period of 2008 to 2012, Africa accounted for 86 percent of world's total cocoyam area harvested and 74 percent of total cocoyam production. The West African sub-region accounted for 61 percent of global area harvested and 50 percent of global production (Onyeka, 2014). Even though, Africa or the West African sub-region remain major cocoyam producers, world estimates indicate a reduction of the contribution from the region to global cocoyam production whereas production contributions from Asia and Oceanian regions (China, Japan, Philippines, Samoa, Papua New Guinea, Tonga and Fiji) have seen significant increase between 2008 and 2012.

Africa's total gross product value (GPV) has decreased by US$ 412 million while Asia's has appreciated by US$ 107 million between 2008 and 2012 (Figure 2.1). Generally, cocoyam production worldwide has slightly decreased by 13.4 percent between 2008 and 2014 (FAOSTAT, 2014). Statistics show that Cameroon and Nigeria are experiencing gradual increase in production as at 2012 even though cocoyam production in Nigeria severely dropped between 2009 and 2011. Figure 2.2 depicts the trend of cocoyam production among the three most important producing countries in Africa. The figure shows that Ghana is experiencing consistent annual production fall since 2003.

**Figure 2.2: Trend of cocoyam production (metric tonnes) in top three producers in Africa**




Source: FAOSTAT (2014)

### 2.3.2 Cocoyam production in Ghana

In Ghana, there are two common varieties of cocoyam; the white and red or mauve types. The root crop usually takes between 12 to 18 months before harvesting. Wright (1930) indicates the root crop was first introduced to Ghana by missionaries from the West Indies. Cocoyam was first planted at Akropong Akuapem in the Eastern Region of Ghana.

The crop gradually spread out to other areas within the forest belt. Cocoyam was easily established within the forest zones of the country mainly because of the predominance of cocoa production along the forest belt. Doku (1967) notes that cocoyam complemented cocoa by providing an ideal shade for cocoa seedlings. A study by Sagoe (2006) also indicate that cocoyam is planted as intercrop with bananas and plantains or with other food crops like cassava and maize. During the early years of establishment, cocoyam was cultivated after virgin forests were cleared. Now, cocoyam voluntarily springs up anytime secondary forests are cleared because of the presence of old pieces of corms and cormels lying dormant in soils of old and abandoned farms (Acheampong *et al.* 2014; Doku, 1967). Cocoyam cultivation is primarily by cutlass and hoe and cultivars are either sourced from own farms, gifted to farmers who need it or purchased from fellow farmers. A major source of planting material is from dormant corms that sprout voluntarily after a piece of land is cleared for farming (Sagoe, 2006).

Cocoyam ranks fifth in importance in terms of production of staple crops in Ghana. Characteristically, it is cropped for its roots (corms) and leaves at subsistence level by farmers. Therefore, only the production surplus is supplied to markets in the urban centres for cash. Onyeka, (2014) noted that during critical periods of crop failure, outbreak of devastating pests and diseases to main crops, drought, famine, conflict or other natural disasters, cocoyam is the staple food that farmers and the rural folks depend on to mitigate hunger. Consequently, cocoyam is the crop that many dwellers in the rapidly growing urban centres consume especially in off-season times of plantains (Acheampong *et al.* 2014).

Cocoyam generates significant amounts of foreign exchange for the country through exports. Cocoyam export therefore, generates further employment along the value chain. Cocoyam exports are low relative to yam however export volumes have fluctuated in recent times. The export market for cocoyam presents itself with a vast potential due to the demand for both corms and leaves largely by West Africans living in the diaspora and the good export value per tonne which favourably compares with that of yam.

Available export data from the Ghana Export Promotion council (GEPC) show that between 2000 and 2013, Ghana has exported 2176.88 metric tonnes of cocoyam worth about US$1,170,642.

Between 2000 and 2013, Ghana exported an average of 167 metric tonnes of cocoyam annually, mainly to the United Kingdom and other EU markets (Acheampong *et al.* 2014; GEPC, 2013). Sagoe *et al.* (2006) noted that the number of cocoyam and yam export dealers, Ghana Root Crops and Tubers Exporters Union (GROCETU), was more than cassava exporters for the same period from 61 participants to 249 participants; tonnes of cocoyam and yam exported increased as the number of exporters increased. Table 2.2 presents information on volumes and value of foreign exchange that cocoyam export contributed to Ghana's economy from 2000 to 2012.

**Table 2.2: Export volumes and values for cocoyam in Ghana between 2000 and 2012**

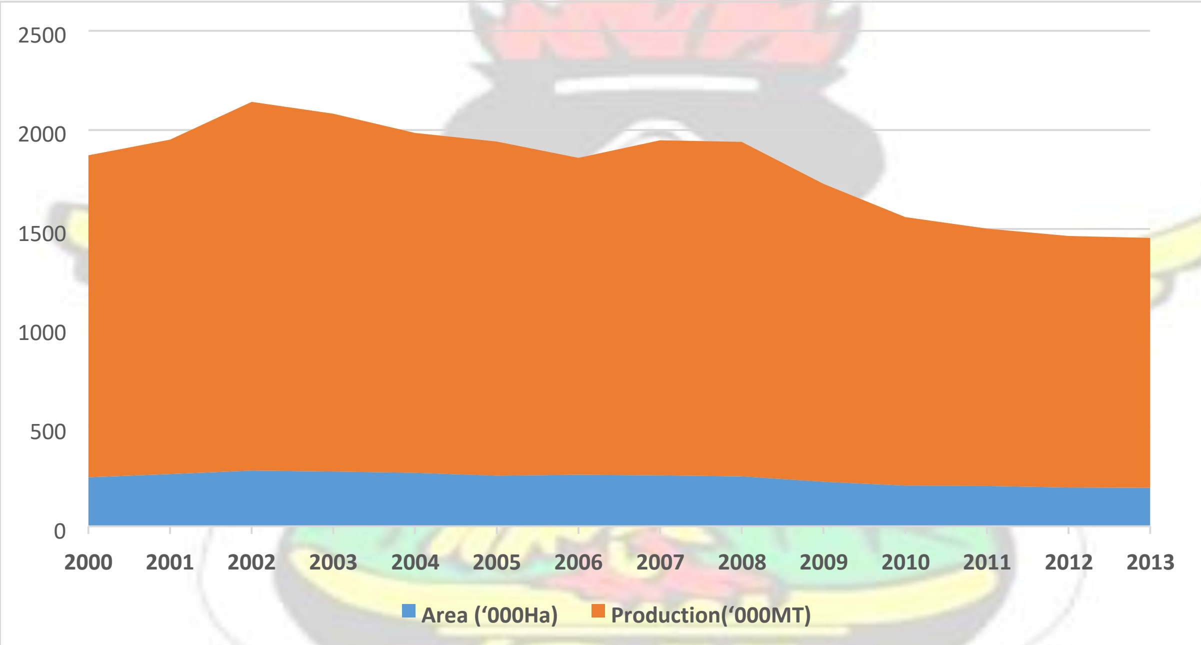
| Year | Quantity | Value (US$) | Total export value |
|---|---|---|---|
| 2000 | 117 | 464.9 | 54393.3 |
| 2001 | 172 | 343.0 | 58996 |
| 2002 | 224 | 347.3 | 77795.2 |
| 2003 | 228 | 364.0 | 82992 |
| 2004 | 64 | 562.5 | 36000 |
| 2005 | 189 | 507.9 | 95993.1 |
| 2006 | 243.7 | 634.3 | 154597.9 |
| 2007 | 234 | 485.0 | 113509.4 |
| 2008 | 272.2 | 776.0 | 211250.5 |
| 2009 | 241.8 | 678.9 | 164178.4 |
| 2010 | 96.8 | 603.6 | 58452.6 |
| 2011 | 61.5 | 832.2 | 51171.9 |
| 2012 | 32.7 | 345.7 | 11311.3 |

Source: Acheampong *et al.* (2014)

Available statistics show that by 1996, Ghana was the world's leading producer of cocoyam contributing 1.6 million tonnes per annum representing 36.4 percent of world's total production (Onyeka, 2014). Percentage contribution to world production has subsequently decreased.

In 2013, Ghana contributed about 13 percent of the world's total cocoyam production (FAOSTAT, 2014). Production in Ghana appeared to have peaked between 2007 and 2008, but that was not sustained for long because production started declining till 2013. Onyeka (2014) posits that this period of sharp decrease coincided with the outbreak of taro leaf blight in the sub-region. Between 2003 and 2013, the national cocoyam production level declined by an average of three percent annually (MoFA-SRID, 2013). Figure 2.3 shows the production trend and area harvested from the 2000 crop year to 2013.

**Figure 2.3: Trend of cocoyam production and area harvested from 2000-2013**



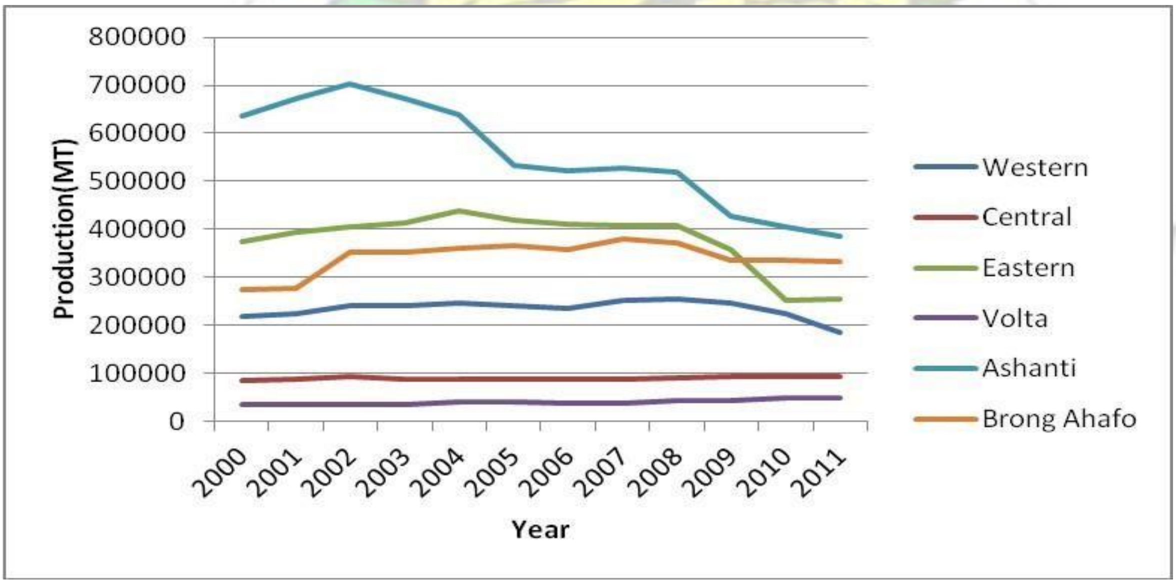

Sources: (FAOSTAT, 2014; MoFA- SRID, 2013)

Annual production statistics from MoFA-SRID (2013) reveal that national average output of cocoyam has declined by about 25.2 percent between 2000 and 2013. Notably, between 2000 and 2013, national production peaked in 2002 with 282,000mt of cocoyam but Ghana could produce only 196,000mt as at 2013. National production information on cocoyam leaves is hardly available however, since both the corm and leaves are composite products of cocoyam, production decline will also be reflected in the output and availability of cocoyam leaves.

Putting the current state of cocoyam production in proper perspective, MoFA-SRID (2013) showed that unlike cocoyam, cassava, yam, maize and rice produced in Ghana have seen increased production between 2002 and 2012. Between 2002 and 2012, cassava, yam, maize and paddy rice production grew by 49.5 percent, 70.2 percent, 39.3 percent and 71.8 percent respectively whereas cocoyam production decreased by about 32 percent for the same period of 10 years. The average negative growth rate in total production for cocoyam can most likely be attributed to reduction suitable lands for production. The root crop is most suitable in the forest areas of Ghana hence the bulk of cocoyam is produced along the forest belt of Ghana however, the alarming rate of forest degradation in Ghana resulting in limited suitable lands for cocoyam cultivation (MoFA, 2015; Quaye *et al*. 2010).

Cocoyam production occurs in the southern parts of Ghana where there are lots of vegetation cover and relatively well distributed amounts rainfall. Ashanti, Eastern, Brong Ahafo and Western Regions of Ghana are noted for the production of cocoyam even though other regions like Volta and Central Regions produce the root crop albeit on a minimal or purely subsistence scale. The major cocoyam producing regions (Ashanti and Eastern Regions) have experienced the hardest decrease in production with the exception of Brong Ahafo which has attained relatively steady production levels as can be seen in Figure 2.4 (Acheampong *et al*. 2014).

**Figure 2.4: Regional production trend of cocoyam (2000-2011)**




Source: (Acheampong *et al.* 2014; MoFA-SRID, 2013)

Regional production statistics reflects a similar trend (Figure 2.4). Ashanti, Brong Ahafo and Eastern Regions, which are the major cocoyam producing regions, have experienced significant drops in the volumes of cocoyam produced by famers since 2000. Cocoyam output from other regions like Western, Central and Volta Region have been fairly stable however, significantly low compared to the three major regions.

#### 2.3.2.1 Cocoyam yield and area of harvest

MoFA-SRID (2013) indicates that the national average yield falls 19 percent short of the national achievable yield of 8mt/ha. However, research has shown that cocoyam can yield as high as 30mt/ha (Ekwe *et al.*, 2009). Egypt records the highest average cocoyam yield of 37mt/ha whereas that of Nigeria and Cameroon (Africa's top producers of cocoyam) is about 6.5mt/ha and 9.6mt/ha respectively (FAOSTAT, 2014). In a study by Quaye *et al*. (2010), the average yield of cocoyam was reported to be 6.2mt/ha. Similar empirical studies in Ghana by Acheampong *et al*. (2014) also stated the average yield of cocoyam ranging from 4mt/ha to 6mt/ha acknowledging that yield are lower in farmers' fields probably because cocoyam was mostly cultivated as an intercrop.

Underlying the production dwindle of cocoyam in Ghana, is the reduction in cultivable areas committed to producing cocoyam in spite of a steady yield of 6.5-6.8mt/ha.. In 2003, about 276,700 hectares of cocoyam were harvested in Ghana. By 2013, the harvested area for cocoyam had reduced by about 30 percent to 193,998 hectares. Ghana contributes 13.8 percent of the world's total harvested area for cocoyam (FAOSTAT, 2014) and this ranks the country as second highest in terms of total area harvested. However, the country ranks fourth in terms of world production quantities and 25th in terms of cocoyam yield. This scenario shows that yield in Ghana is considerably low relative to other major world producers. As stated by Onyeka (2014) and Sagoe *et al.* (2006) cocoyam production in Ghana is neither mechanized nor modernized hence expansion of production involves increasing acreages rather than improving productivity by employing improved and productive resources on a piece of land or both.

Individual cocoyam farm sizes in Ghana are mostly one hectare or less. Not many empirical studies have been conducted at the farmer level on areas under cocoyam cultivation in Ghana. However, Quaye *et al.* (2010) revealed that cocoyam was cultivated predominantly on small scale with an average farm size of 0.8 hectares. Similarly, a study by Acheampong *et al.* (2014) in Ghana, put forward that cultivation of cocoyam is done on scattered plots of sizes between 0.2 and 0.5 acres. Another study by Emodi *et al*. (2014) in Imo State of Nigeria showed that 90 percent of the producers cultivated cocoyam on a hectare or less of farmland. Ajijola *et al.* (2003) also found the average cocoyam farm size of producers to be 0.54 hectares confirming that cultivation of the crop is generally on a small scale.

### 2.3.3 Economics of cocoyam production

Not many recent studies have been undertaken on the economics of cocoyam. Cocoyam cultivation is considered as labour-intensive activity making labour one of the most significant resources in its cultivation. Wilson (1980) identified that planting cocoyam requires more labour compared to cassava. Quaye *et al.* (2010) also found out that the next most labour intensive activity in cocoyam cultivation was harvesting. In Knipscheer and Wilson (1980), labour utilization in cocoyam production was reported as about 142 man days per ha of which women and family labour as a major source for production. The study recommended that increased attention be given to cocoyam breeding due to its economic value and potential. On the other hand, Quaye *et al.* (2010) found that the average cocoyam producer employed about 120 man-days of labour per hectare. The increase or decline in cocoyam output has been largely due to increase or decrease in harvested area rather than increase or decline in productivity (yield). This could be attributed to the fact that cocoyam production is done largely with minimal input and on marginal soils (Onyeka, 2014). Some scholars have held the position that cocoyam producers over-utilize resources especially labour. Ajojola *et al.* (2003) in Owo StateNigeria, found that resource use was characterized by over-utilization of labour and underutilization of area cultivated and planting material. The study indicated that cocoyam production is experiencing increasing returns to scale. In a study by Anyiro *et al.* (2013) also found that women cocoyam farmers operated at the first stage of production. The findings showed that labour, fertilizer, farm size as well as depreciation of capital assets were not utilized at the economic optimum level on cocoyam farms.

## 2.4 Determinants of crop production

Production according to OECD (2001) is defined as an economic activity performed under the responsibility and control of an institutional entity which employs inputs of labour, capital and goods and services to produce outputs of goods and services. Agricultural production is affected directly and indirectly by many factors because farmers decide what to grow, the level and type of inputs use as well as the methods of production to be used constantly. Farmers' decisions are based on a range of factors (Abrha, 2015). Studies have classified these factors influencing crop production into various broad categories. Categorization of production determinants are often based on the relationship and similarities of the asserted factors as well as the point of view of the authors. This section simply categorises and reviews determinants of production under basic production factors or agricultural inputs, socio-economic factors and physical or institutional factors.

#### 2.4.1. Production factors (agricultural inputs)

Production factors include the basic inputs required for agricultural production. These are seed or planting material, fertilizer, land and labour. Agricultural advancement has given rise to technologies and innovations which enhance the use of basic input factors for maximum output. Specifically, these technologies include high yielding seeds or planting materials, chemical fertilizers and other soil enhancing technologies (Abrha, 2015).

##### 2.4.1.1. Seed or planting material

Seeds are the most critical factor of agricultural production. The quality of seed affects the level of yield of farmers and has a positive impact on land productivity. The yield and value of crops is significantly increased by improved seeds through genetic manipulation of selective breeding (Sassenrath *et al*., 2008). Alemu *et al*. (2005) and Kugbei (2011) notes that improved seeds combined with good cultivation practises and modern science results in an improved agricultural productivity and production.

Kugbei (2011) investigated the efficiency of wheat seed production and found that the average yield obtained from improved wheat seeds was about 33 percent higher than yield from local seed varieties. Small scale farmers, often times, do not use certified (improved) seeds mostly due to financial constraints and lack of awareness (Langyintuo *et al*., 2008). In Sub-Saharan Africa and other developing countries, the practise of small scale farmers have been to continuously recycle seeds by selecting from stored seeds after every harvest for planting the following season.

Douglas (2008) notes that such practise affects crop output in terms of quality and quantity but farmers adopt this practise as a way of reducing cost of production (Rohrbach *et al.*, 2003). Indigenous (unimproved) planting materials are often low yielding and sometimes already infected with certain diseases.

In Ghana, cultivation of cocoyam and other roots and tubers is mainly through the use of indigenous cultivars via vegetative propagation. Currently, there are only three improved cocoyam varieties released by through WAAPP intervention for farmers' use. These are SCJ/98/005, AGA 97/162 and SW011 (Domfeh, 2014). The challenge has been with commercialization of the improved planting materials, lack of access and adoption of this agricultural technology due to farmers' lack of knowledge of improved varieties (Acheampong *et al*. 2014; Quaye *et al*. 2010). Cocoyam producers also benefit from volunteer sprouting. Aside planting with corm setts, a certain proportion of cocoyam farms voluntarily sprouts. It is also known that volunteer crops mature faster than planting with corm setts but have relatively lower yield. Cultivation, using treated corm setts however, appears to be more sustainable. A cocoyam mini-sett technique developed in Nigeria for enhanced multiplication of planting materials was found to reduce cost of planting material by 40 percent and increase yield to about 15-20mt/ha (NRCRI, 2015).

#### 2.4.1.2. Land size

Agricultural production has land as one of its indispensable resources. In Ghana, where the agricultural sector is regarded as the engine of the economy, land is the most critical natural resource. Larger farm sizes have been associated with higher outputs and increased farm income if there is sufficient (family) labour available (Hedican, 2006). In other words, farmers who possess or control more land are in a better position to increase yield and expand production. On the other hand, some empirical evidence such as Dyer (1996), highlights the evidence of an inverse relationship between farm size and yield. Dyer (1996) posits that farmers with relatively small land sizes are more productive than farmers with larger farm sizes or landholdings.

Agricultural expansion and increased production in developing countries like Ghana results mostly from increasing area cultivated rather than intensification which involves the use of agricultural production technology such improved seeds and fertilizer usage (Mbabazi *et al*., 2015). Farm sizes are based on the size of land allotted for particular crops by producing households (Kim and Park, 2009).

Access to cultivable land by small scale farmers is therefore a big challenge and is affected by several other factors including land tenure, gender and population increase. The rising population pressure has also been identified as another cause of land scarcity. Jayne *et al*. (2014) posits that population pressure leads to shrinking sizes of farmlands of smallholder farmers with time, continuous cultivation of farmlands and the increase in land rent and market price of farmlands. Most farmers have limited access to enough land hence farmlands are subjected to fragmentation for cultivation of various crops by the same household. Raghbendra *et al.* (2005) asserted that land fragmentation has a negative impact on yields.

Soil fertility or the quality of land also impacts output significantly. Studies like Sanchez *et al*. (1997) have suggested that in sub-Saharan Africa, soils are rapidly degrading. Sanchez *et al*. (1997) linked poor soils to low production stating that the depletion of soil fertility in smallholder farms is the biophysical root cause for declining per capita food production in subSaharan Africa. Onyeka, (2014) also attributed low production of cocoyam across West Africa to declining soil fertility as well as land degradation that causes reducing forest frontiers which are most suitable for cocoyam production.

**2.4.1.3. Fertilizer**

The complexity of land and labour scarcity makes the use of (organic and inorganic) fertilizer more critical in the intensification of crop production. The depletion of soil nutrients as a form of land degradation has dire economic impact both at the national global scale, especially in Sub-Saharan Africa. In a study that investigated the nutrient balances for 38 countries in SubSaharan Africa, Stoorvogel *et al*. (1993) estimated the annual depletion rates of soil fertility at 22 kg nitrogen (N), 3 kg phosphorus (P), and 15 kg potassium (K) per ha. Small scale farmers apply limited amounts of fertilizer to their crops. Fertilizer application in SSA is considered below standard and the lowest rate globally i.e. averagely 11 kg/ha compared to 130kg/ha in South Asia and 271 kg/ha in East Asia (de Janvry, 2010; Xu *et al*., 2009).

The low rate of fertilizer use in Africa accounts for the below average area productivity (Kuhn *et al.*, 2010). Since 2008, Government through MoFA has promoted the use of fertilizers for enhanced food production and security through interventions like the fertilizer subsidy programme (Krausova and Banful, 2010). In Ghana, plantation crops and cereals production receive relatively more fertilizer application than roots and tuber crops. Farmers can access fertilizers directly from wholesalers or the rural retail shops. According to the FAO, there are about 700 rural retailers of fertilizers spread throughout the country, with the highest concentration in the maize belt in the Brong Ahafo region. Imports of chemical fertilizer into

Ghana has seen an increase over the years. In 2001, a total of 808,000 tonnes of fertilizer were imported representing over 30 percent increase since 1997 with oil palm production being the heaviest consumer of chemical fertilizer (FAO, 2005).

Cocoyam production in Ghana is characterised by minimal application of fertilizer. When cultivated as an intercrop especially with cocoa or maize, cocoyam benefits from fertilizer applied to the main crops (Acheampong *et al*., 2014 and Quaye *et al*., 2010).
Research has linked low fertilizer usage to the high cost of input leading to increased production cost amid the risks or uncertainties of production (delayed rains, poor weather, crop failure etc.) which will impact farm profitability. The high cost of fertilizer could be as a result of supply related factors such as non-competitive behaviour of fertilizer suppliers, transportation costs and inadequate fertilizer purchase arrangements between importers and traders. Other reasons put forward to explain low fertilizer usage include; limited access to credit to buy fertilizers, lack of access to fertilizer and lack of knowledge on application methods and rates (Morris *et al*., 2007; Crawford *et al*., 2003). Another reason is linked with the perception of producers that fertilizer application reduces the storability and affects the taste of their produces especially roots and tubers.

Uwah *et al*. (2011) confirmed that organic manure and mineral fertilizer promotes growth and yield of cocoyam. In an experimental study on the effect of (organic and mineral) fertilizers on cocoyam yield reported that corm yield optimized at 10mt/ha with fertilizer application rate of 80kg K/ha. Cocoyam yield of peaked at 15mt/ha when application rates increased to 120kg K/ha. The study further noted that a combination of poultry manure and mineral fertilizer (either 80/120kg K/ha) also yielded 15mt/ha thus out-yielding all other treatments of the trial in terms of corm weight and total yield.

**2.4.1.4 Labour**

Agricultural production requires the use of labour in every activity carried out ranging from land clearing and preparation, crop husbandry to post-harvest activities. Shortage of labour affects output since activities that need to be carried on the field will also be affected. Labour shortage causes many farmers to shift from transplanting seedlings to manual broadcasting.

Farmers also divide their total agricultural lands to manageable portions thereby reducing the areas available for planting (Rickman *et al*., 2013). The challenge of labour in crop production is the availability at critical times especially at peak times. The need for labour is heightened for production of crops like cocoyam which is often done in small holdings where manual labour with hand tools is the production method and is considered laborious especially during weeding, planting and harvesting activities (Onwueme and Charles, 1994).

Larger farms will engage hired labour only until the marginal product of labour is equal to the minimum wage. Thus, there will be unemployed labour and the opportunity cost of employing family labour will be low on small-scale farms (Verma and Bromley, 1987). The influence of labour on increasing production is however not in doubt in literature.

Abugamea (2008) concluded in a study on the dynamics for agricultural production that an increase in labour also increased output. Family labour is the cheapest and most reliable source of labour for production. However, there are divergent schools of thought on the advantages of family labour as labour source. Shumet (2011) and Askal (2010) posited that larger households are more advantageous to manage weeding and harvesting activities than smaller households. Contrary to these findings, Coelli, *et al*. (2002) in Bangladesh, as cited in Askal (2010), indicated that farmers with large family size were characterized by poor resource allocation mainly labour and chemical fertilizer unlike those with small family size members and the latter were more productive.

**2.4.1.5 Herbicides/weedicides**

Weeds compete with economic crops for basic requirements like space, water, nutrients, and carbon dioxide. Weeds decrease yield by up to 20-40 percent. Yield losses have been reported to as high as 100 percent depending density of weeds and intensity of competition (Oad *et al.*, 2005; Ashiq *et al*., 2003).

The use of weedicides is one of the best labour saving activities for weed control in crop production however, literature is split on the direct or indirect effect weeding has on output or yield. Studies that posit a negative effect of weedicides on yield actually point to the effect that such chemicals have on the soil organisms and microbes in the soil which enhance soil structure. For instance, Choudari *et al*. (2010) indicated in a study on the effect of weedicides on microbial population and yield of soybean that, herbicide application influenced soil biological activities by inhibiting soil microbes and eventually yield. The study points to manual weed control as increasing yield without affecting microbial population.

Raza *et al*. (2015) on the other hand, asserts that the use of weedicides resulted in significant control of weeds and improved yield of wheat by considerably eliminating competition posed by weeds.  In Ghana, incidence of weeds have been cited as a major constraint of production but herbicides application is minimal in cocoyam production. Producers sparingly apply weedicides to cocoyam because of the potential effect that the agrochemicals have on the plants and its suckers. The use of total weed killers in cocoyam production has resulted in the depletion of voluntary cocoyam and withering of the plants (Sagoe, 2006 and MoFA, 2015). WAAPP (2010) noted that cocoyam farmers only apply herbicides to burn weeds that still remain after land clearing and not to burn weeds after the cocoyam plants have established.

#### 2.4.2 Socio-economic factors

Socio-economic characteristics consists of many variables that affect crop production. Some of these variables that were reviewed include gender, age, education level, household size and farming experience.

##### 2.4.2.1 Gender

Gender is defined as socially constructed roles and relationships of men and women within a particular geographical location or culture (Adeoti *et al.*, 2012). Crop production involves the participation of both men and women at different stages playing different roles. Women are known to be food producers at subsistence level and hence responsible for ensuring that the basic food needs of the family are met whereas men are viewed as being responsible for the production of cash crops (Burton, 2013; Doss 2002). Hence, the categorization of some crops as “men’s” crops” and others as “women’s crops” (Onyeka, 2014). Women tend to be the major players in terms of farm labour force for activities like production, harvesting and processing. (Jafry and Sulaiman, 2013).

Due to the social contrast in roles and responsibilities, access to productive resources have been found to differ. Women farmers are challenged with direct access to capital, land, labour, information and markets which hamper the capacity to produce effectively and to fulfil basic necessities (Jafry and Sulaiman, 2013). In most cases, the tradition of handing over lands happens from fathers to sons while daughters are denied ownership. Women often have indirect access to farmlands through their husbands and even if women do own lands, land sizes tend to be smaller and located at marginal areas. The fact that land rights belong to men only makes women voiceless in the ownership of land (Githinji *et al.*, 2014; Alston, 2003; FAO, 2002).

The productivity of male and female farmers have mixed results in literature with some showing no significant difference between gender productivity like de Brauw *et al*. (2013) while others found differences for example Walker (2015), Ragasa *et al.* (2013) and Njuki *et* *al.* (2006). Findings put out by Walker (2015) show that male farmers are about three times more productive than female farmers. Njuki *et al*. (2006) and Ragasa *et al*. (2013) also established that male farmers are more productive than their female counterparts in mechanized farms. The study added that the apparent difference in productivity can be attributed to access to quality extension services, inputs and land. If all other factors were constant, there will be no productivity differences (Njuki *et al*., 2006). FAO (2010) stated that if women had the same access to productive resources as men, their farm yields could appreciate by 20-30 percent.

#### 2.4.2.2 Age and farming experience

Age and farming experience have often been related to each other and both are considered to affect crop output (Shumet, 2011; Amaza *et al.*, 2006). The higher one's age, the higher the farming experience and hence production will increase however, up to a certain age limit. Farming experience is informal education. In Nigeria, Adomi *et al.* (2003) put forward that farmers depend on the accumulated knowledge of farm practises in producing different crops therefore *ceteris paribus*, experienced farmers enhance the productivity of their farms. However, after a certain age limit, production is expected to fall. Since agriculture in developing countries is mainly labour-intensive, older farmers, even though may have enough experience, lack of physical strength may cause them to increase conservativeness. Production and productivity will then fall subsequently after certain age limit of producers (Burton 2013; Shumet, 2011).

#### 2.4.2.3 Education

Education is an important factor in determining crop production because it influences farm management practises and the adoption of agricultural technologies for enhanced production. Formal education improves the participation of producers in environmental programs and sustainable agricultural methods (Burton, 2013). Shumet (2011) explained that educated producers have better access to agricultural information which is fundamental in the decisions of what and when they produce, adoption of technologies as well as input use efficiency thus increasing production. Compared to uneducated farmers, the educated ones are in a better position to process information, efficiently allocate inputs and to assess the profitability of new technologies (Adegbola and Gardebroek, 2007). On the other hand, a study by Lugandu (2013) in Tanzania suggests that farmer enlightenment through formal education paves way for increased participation in off-farm activities which tend to make agriculture less attractive.

#### 2.4.2.4 Household size

Household size is considered a factor that influences production in terms of access to readily available cheap labour for farmers. Studies like Bassey and Okon (2008) have suggested positive influence of the size of household on crop production. On the other hand, Bassey *et al.* (2014) and Nandi *et al.* (2011) posit that larger households have negative impacts on production. A larger household size does not necessarily translate into available farm labour force because household members may be engaged in other economic activities other than farming (Bassey *et al.*, 2014).

Olayemi (2012), in a study on small farmers noted that agricultural production in SSA is generally labour intensive hence it is not possible to expand the size of farmlands without matching it with an increase in household size. Even though large household size puts extra pressure on farm income for household expenditure like food and clothing, it is associated with availability of enough labour force for farming activities to be performed timeously (Bamine *et al.* 2002; Abdulai and Eberlin, 2001).

#### 2.4.2.5 Off-farm income

Engagement of farmers in off-farm activity has mixed effects on crop production. Off-farm activity generates capital endowments for farmers to acquire inputs like improved varieties, fertilizers and other agrochemicals. Rios *et al*. (2008) purport that off-farm income is a source of capital for agricultural investment for producing households and thereby result in high production and productivity.

A study by Lien *et al*. (2010) on the determinants of off-farm work showed that off-farm work or income has a positive significant effect on farm output. Conversely, income from off-farm activities may tend to impact negatively on production as it increases due to the fact that households may rationally substitute time for agriculture on off-farm activities and this will minimize crop output (Pfeiffer *et al.*, 2009). A decline in farm income and production leads farmers to increase participation in non-farm enterprises whereas the vice versa holds, all things being equal (Zahonogo, 2011). Off-farm activity is a form of income diversification and plays an indispensable role of improving the livelihood of the rural poor (Asenso-Okyere and Jemaneh, 2012).

### 2.4.3 Institutional and agronomic factors

The various institutional and agronomic factors that affect crop production include the type of cropping system practised, continuous cropping, extension contact and harvesting of leaves.

#### 2.4.3.1 Cropping system and continuous cropping

The two main cropping systems predominant in agriculture are intercropping and sole cropping in Ghana. Intercropping helps to ensure a good soil moisture as well as decrease the incidence of pests and weeds. According to Loos *et al.* (2001), intercropping increases the income per unit of land and labour of producers and hence can be economically more profitable than mono cropping.

Intercropping is the commonest cropping system practised by farmers in developing countries and it enhances the total farm yield by using resources which cannot be used by a single crop (Guvene and Yildrim, 2006). In ensuring quality and yield in intercropping systems, crops planted must be complementary in resource utilization.

In SSA, intercropping is practised basically to fulfil the food needs of farming households but farmers are often not particular about the crop mix hence are not able to benefit from optimum yield and returns (ibid.). Yield of the main crop tends to be affected under the intercropping system due to competition. On the other hand, sole cropping system significantly increases crop yield with the use of agricultural technologies like fertilizers, pesticides and recommended spacing (Karlidag and Yildrim, 2009). Unlike intercropping, sole cropping is most suitable for mechanized, intensive cultivation and can give maximum output of the main crop. Kasenge *et al.* (2001) studied the impacts of mono cropping and intercropping systems on maize yield and returns in Uganda and concluded that yield was higher in the monoculture than under the intercropping system.

Closely tied to the cropping system practised by farmers is the issue of continuous cropping. It involves cultivation of crops each successive year without a period of fallow. This practise contributes to a rapid depletion of soil quality and hence productivity. Liu *et al.* (2003) acknowledged that the continuous cropping impacts negatively on yield hence, it is not the most appropriate soil management practise for maintaining soil productivity. It is common practise though, that farmlands in developing countries are subjected to continuous cropping due to access to land constraints to practise crop rotation and lack of capital and credit to purchase soil nutrient enhancers (Ogutu and Obare, 2015).

#### 2.4.3.2 Extension contact

Extension service play the role of improving the livelihood of farmers through the transfer of knowledge based on research in the agricultural sector. Extension agents are responsible for translating findings of agricultural research institutes to producers while sending feedback on challenges of farmers back to the research institutions (Ajani and Onwubuya, 2013; Rivera, 2011). Their importance in enhancing agricultural production is well noted in literature. A study carried out in China by Hu *et al*. (2008) indicated that extension service is a vital source of first-hand information on agricultural technologies for farmers and sometimes other information not directly related to agricultural extension like health, family planning, budget management, legal matters among others.

The extension agents are key players in instigating farmers to adopt and use agricultural inputs and innovations by guiding them on how, where and when to use inputs (Genius *et al.*, 2013; Jamilah, 2010). Effectiveness of extension service is dependent on the competence of extension workers to disseminate information to farmers. A study in Nigeria by Ajayi *et al*. (2014) showed a positive impact of extension contact on maize output citing that producers with higher extension contact are more likely to receive and adopt recent agricultural information to boost production.

#### 2.4.3.3 Leaves harvesting

Certain crops, especially root and tuber crops (cassava and cocoyam) are composite in nature i.e. both the leaves and roots are consumed especially in Africa. The main economic part of such crops are often the roots even though their leaves are edible and of significant demand. The leaf is one of the most vital components of the plant and is responsible photosynthesis.

For crops like cocoyam, crop development takes three major stages i.e. plant establishment (spans up to two months after planting); vegetative growth (between two to five months after planting) and tuber development and maturity (after 5 months) (Adiobo *et al*., 2011). Asumadu *et al*. (2011) conducted an experimental study on the effect of leaves harvesting on corm yield in Ghana noted that the timing, frequency and amount of leaves harvested can affect vegetative growth rate and the yield of corm which is the main economic part. The study showed that yield of cormels for no leaves harvested was significantly higher than all other treatment combinations. Similarly, Safo-Kantanka *et al*. (1987) also showed that leaf harvesting resulted in a significant reduction in corm yield.

The need for proper development of plants with edible leaves are required to sustain them. For instance, cocoyam producers are aware of the potential impact of leaves harvesting on corm yield therefore, in order not to affect corm development and yield, producers of roots and tubers sometimes stagger and scatter periods of leaves harvesting (Quaye *et al*., 2010). Commencement of leaves harvesting should be about 20 weeks after planting at which point harvesting of leaves may have no significant impact on cormel yield (Asumadu *et al*., 2011). The demand for the leaves and the relatively higher price per kilogram (GH¢1.11/kg) compared to the cormels (GH¢0.32/kg) tend to force farmers to practise early leaf harvesting which ultimately impacts on corm yield (Asumadu *et al*., 2011).

## 2.5 Production function theory and estimation approaches

Production function is defined as the technological relationship between factors of production and resultant outputs. It shows the average level of outputs that could be produced out of a given amount of input used (Pascoe *et al*., 2003; Schmidt, 1986). A production function therefore describes the boundary representing the achievable output limits for a set of input combinations. It can be mathematically expressed as:

$$f(x) = \max\{y: y \in (x)\} \quad (2.1)$$

Where $y$ is a scalar (output) and $x$ is a scalar or a vector of the input. Classically, the fundamental factors of production are land, labour and capital. Estimation approaches of production function differ based on the characteristics and assumptions of the error term of the production function i.e. stochastic production functions and non-stochastic production functions. The implicit assumption of non-stochastic production functions is that firms produce in a technically efficient manner and the typical firm defines the frontier.

As a result variations from the boundary are assumed to be one-sided and random. On the other hand, stochastic production frontiers assume that part of the noise can be attributed to technical inefficiencies (Pascoe *et al*., 2003).

### 2.5.1 Stochastic production frontier

Stochastic production frontiers have often been applied to estimating technical efficiencies but this technique can also be applied to capacity or production estimations (Pascoe *et al*., 2003). The frontier analysis is generally grouped in two i.e. parametric and non-parametric approaches. The non-parametric approaches employ the use of mathematical programming techniques. This approach was first advanced by Farrell (1957) and subsequently by Charnes *et al.* (1978). It is usually known as the data envelopment (DEA) analysis. On the other hand, the parametric approach uses statistical and econometric procedures (Coelli *et al*., 1998). There are profound differences between these approaches. The basic characteristic difference is that the parametric approach to frontier analysis imposes functional forms while the DEA does not.

This happens to be the main weakness of the stochastic frontier approach because some arbitrary functional forms need to be specified for the frontier. Even though, specification of more general distributional forms for both the frontier and the one-sided error has partially alleviated the problem, the resultant efficiency estimates may still be sensitive to the underlying assumptions (Coelli *et al.*, 1998).

According to Greene (1980) there are two basic categories of parametric frontiers called the stochastic and deterministic frontiers. The stochastic frontier approach (SFA) assumes that deviations from the frontier can be decomposed into two statistical factors i.e. inefficiency of the producer or character under study and inevitable random shocks. DEA on the other hand, simply assumes that all deviations from the frontier are attributable to the inefficiency of the character under study.

This simplistic assumption indicates that measurement and other stochastic errors in the dependent variable are contained in the error component thereby making such estimates sensitive. Stochastic frontier analysis remedies this by introducing a decomposed error structure with a two sided symmetric error term and a one sided random error component. The stochastic frontier approach is more flexible and useful because it lends itself to further analysis like testing of various statistical hypotheses and standard error estimations (Greene, 2008). The stochastic frontier approach for production was first proposed by Aigner *et al.* (1977) and Meeusen and van den Brock (1977). However, Battese and Coelli (1995) made an improvement to the model. The model is expressed as:

$$Y_i = f(X_i;\beta) + v_i - u_i \qquad i = 1,2,3,\ldots\ldots.n \qquad (2.2)$$

Where; $Y_i$ = output of the *i*-th firm; X = vector of inputs; β = vector of parameters to be estimated; *f* (.) represents the functional form; $v_i$ = two sided random error term assumed to be identically and independently distributed (iid) with a normal distribution [N (0, $\sigma v^2$)] whereas $u_i$ = one-sided non negative random error that captures technical inefficiency of production. The *v* and *u* terms are assumed to be independent of each other. Error term *u* measures the inefficiency component i.e. the gap in output from its estimated maximum value given by the stochastic frontier, whereas *v* is made up of stochastic effects beyond the control of the firm such as measurement error, labour performance, disease outbreaks, floods, drought and other statistical noises (Battese and Coelli, 1995).

Battese and Coelli (1995) also indicates that effects of technical inefficiency in equation (2.2) can be expressed in a linear function of independent variables showing specific characteristics of a farmer. The term $u_i$ is assumed to be independently distributed and obtained by truncations at zero of the normal distribution with variance $\sigma_u^2$ and mean $u_i$ is defined also as:

$U_i$ □□$Z_i$ □$w_i$ (2.3)

Where; $w_i$ = a random variable defined by the truncation of the normal distribution with a mean of zero and variance $\sigma^2$ such that the point of truncation is equal to $-Z\delta$, i.e. $w_i \geq -Z\delta$. These assumptions are consistent with $u_i$ being a non-negative truncation of the $N(Z\delta, \sigma^2)$ distribution. $Z$ is a set of explanatory variables and δ is a vector of unknown coefficients. The coefficients $\beta$ and $\delta$ and the variance parameters $\sigma^2$ and $\gamma$ are all estimated by the maximum likelihood estimation (MLE) procedure. The likelihood function expressed in terms of the parameters of variance $\gamma$ is given as ($\sigma_u^2/ \sigma_s^2$) and $\sigma_s^2$ is given as ($\sigma_u^{2+}\ \sigma_v^2$) where $0 \geq \gamma \geq 1$. When $\gamma = 0$; it means that deviations from the frontier are entirely due to random error or noise. Whereas $\gamma$ = 1 also implies that frontier deviations are as a result of technical inefficiency (Battese and Corra, 1977).

#### 2.5.1.1. Functional forms for production functions – a case of Cobb Douglas versus Translog

As already highlighted, estimation of stochastic production frontiers requires that a certain functional form is imposed. A variety of functional forms for stochastic frontier production analysis abound. The choice or selection however is dependent on appropriateness to fit data, computational ease or complexity, flexibility of functional form and preference of researcher. Apart from the Cobb Douglas and Translog production functions, other production functional forms include constant elasticity of substitution production, Tobit and bootstrapped functional forms. According to Greene (2008), the transcendental logarithmic (Translog) and CobbDouglas stochastic production frontier models overwhelmingly dominate in terms of applications in literature in stochastic production frontier and especially econometric inefficiency estimation.

Pascoe *et al.* (2003) noted that the translog functional form is the most frequently used followed by the Cobb Douglas functional form. Translog is mostly used due to its relative flexibility as it allows for interactions of explanatory variables i.e. it does not impose any *apriori* assumptions about constant elasticities of production. The Cobb Douglas is also preferred due to its simplicity and convenience (Bhanumurthy, 2002).

In general, the Cobb Douglas production function can be expressed as follows:

$$\ln Q_{j,t} = \beta_0 + \sum_i \beta_i \ln X_{j,i,t} - u_{j,t} + v_{j,t} \qquad (2.4)$$

And the translog production frontier can be expressed as:

$$\ln Q_{j,t} = \beta_0 + \sum_i \beta_i \ln X_{j,i,t} + \frac{1}{2} \sum_i \sum_k \beta_{ik} \ln X_{j,i,t} \ln X_{j,k,t} - u_{j,t} + v_{j,t} \qquad (2.5)$$

Where;

$Q_{j,t}$ = output of the variable *j* in period *t* and $X_{j,i,t}$ and $X_{j,k,t}$ are the explanatory variable and fixed inputs (*i*,*k*) to the production process. As can be seen, the error term is decomposed into two parts, where $v_{j,t}$ = stochastic error term and $u_{j,t}$ = estimate of technical inefficiency.

The Cobb-Douglas functional form can be considered as the reduced or restricted from of the translog form. However, there are periods when using one over the other is ideal. Pascoe *et al*. (2003) indicates that translog production frontier is more appropriate when it involves a large data set. If not, the process of estimating the translog may cause problems because translog production frontier function usually requires large number of variables, resulting in degree of freedom problems. In such a case, the Cobb Douglas model or more restrictive assumptions must be imposed (ibid.).

According to Tewodros (2001) the selection of a functional form for any empirical study is important because the chosen form significantly influences the parameter estimates. The CobbDouglas functional form is relatively easy to implement however, it imposes severe restrictions on elasticities of production to be constant and input substitution elasticities to be equal to one. On the other hand, the translog functional form is rather less restrictive, allowing for the interaction terms of the explanatory variables so as to enhance goodness of fit to data.

Some studies that have used the Cobb-Douglas production include Okoye *et al.* (2008); Okoye *et al.* (2007); Rahman *et al*. (2012) and Khai and Yabe (2011) whereas studies that have employed the translog functional form include Obasi (2006) and ONto' *et al.* (2012). Asenkeye (2012) also chose the Cobb Douglas functional over the translog form after conducting an LR test in his study.

### 2.6 Empirical studies on determinants of cocoyam production

Empirical studies on factors affecting cocoyam production or determinants of cocoyam production in Ghana were very difficult to find. However, a plethora of such studies conducted in other countries are available for review. Studies have identified several socio-economic and institutional factors that influence cocoyam production.

Some include; area cultivated or farm size, planting materials used, hired and family labour, fertilizer application, cropping systems, gender, land tenure arrangements, farming experience, extension contact and educational status. Gbigbi (2015) explored the potential capacity of cocoyam for poverty reduction in the Delta State of Nigeria. This study fitted the Cobb Douglas production function to the data. The study results showed that respondents were mostly female (85 percent) and small scale cocoyam farmers with majority (69 percent) cultivating less than a hectare. The estimates from the Cobb Douglas production function revealed that planting material, cocoyam farm size, labour and farming experience are the major factors that positively influence output and income.

Eze (2014) set out to investigate the socio-economic determinants of cocoyam production among women farmers in South East Nigeria and highlighted implications for food security and agricultural transformation. The results revealed that farm size, educational status and the annual income of women famers positively influenced cocoyam production. Amusa *et al.* (2011) also found that majority of the cocoyam farmers were male (70 percent) with an average age of 54 years who mostly intercropped cocoyam with cassava, maize and vegetables. The results showed that gender, household size, farm size, land ownership status and farming experience were major socio-economic determinants of cocoyam output.

Azeez and Madukwe (2010) also identified cropping system, labour and quality of planting materials as the major factors that significantly affected cocoyam output positively. The study also showed that females formed majority of respondent farmers while the most pressing constraints of production was lack of capital to invest. Away from the conventional regression analysis approach to identifying factors that affect cocoyam cultivation, a more recent study by

Emodi *et al.* (2014) identified socio-economic determinants of production using the perception approach. The study found income generation and high demand for cocoyam as major factors that farmers perceive to influence production. Notably, no test of agreement or reliability of responses was conducted as part of this study so the validity of farmers' responses cannot be readily verified. In another study on the impact of agricultural extension services on cocoyam production by Olagunju and Adesiji (2011), they found out that labour, fertilizer, farmer's age and number of extension contact as the most significant explanatory variables that influence cocoyam output. Ogisi *et al.* (2013) assessed determinants of production and profitability of cassava and found out that planting material (number of cuttings), hired labour, farm size, farming experience and age significantly influence cocoyam production positively.

## 2.7 Approaches to farm profitability analysis

Profitability is a measure of the ability of an enterprise in using its resources to produce profit or net farm income (CAPI, 2009). Costs and returns are important factors that dominate every decision making process during crop production by the farmers. There are a number of measures and approaches that can be used to determine the financial performance and efficiency of capital use by farm enterprises. The commonest is gross margin approach as specified in Olukosi and Erhabor (1988).

Gross margin estimation provides how much a farm enterprise earns from the sale of its produces and indicates a profitability pattern of aggregate input use. However, gross margin is not an absolute measures of farm profits because it does indicate the relative significance of each of the resources in production (Gomez, 1975). Therefore, making farm investment decisions based on only gross margin estimation could be biased and erroneous because it does not include fixed or overhead costs which are always incurred regardless of the size of a farm enterprise (Kohl and Wilson, 1997). Other profitability measures which consider the relative significance of assets in producing profit include operating profit margin, net farm income, rate of return on assets or investment, return on equity and operating expense ratio analyses among others. Indeed, these approaches to profitability and farm financial performance reflect how various segments of a farm enterprise are faring.

Therefore, employing more than one measure is more appropriate and informative than relying on only aggregate value of farm income or profit (CAPI, 2009).

### 2.7.1. Empirical studies on profitability of cocoyam production

Several analysis on profitability of cocoyam production and other production enterprises have been conducted by researchers. Most studies did not assess profitability as a standalone or central theme of their respective studies but rather a complementary assessment necessary for drawing relevant conclusions based on the central themes. The use of gross margin approach in studies on cocoyam profitability is ubiquitous. However, analysis on the return to capital or investment is very limited. Quaye *et al.* (2010) conducted a study into the socioeconomics of traditional production of cocoyam and its leaves in Ghana. The study found that for each hectare of cocoyam farm, the total cost of production and total revenue were $669 and $1426 respectively with labour constituting 80 percent of the total variable cost. Farmers earned a net revenue of $757 per hectare therefore the study showed that cocoyam production was profitable in the district.

Sagoe *et al.* (2006) also explored profitability of cocoyam under two cropping systems (monocropping and intercropping systems). The study found out that the gross margin for solecropped cocoyam was higher than that for mix-cropped cocoyam. In conclusion, Sagoe *et al.* (2006) indicated that the farm enterprises experimented on different sites were economically viable and profitable giving cost-benefit ratios of more than one. The study goes further to recommend cultivation of cocoyam as a sole crop over the mixed cropping system because the former produces better yield and returns more income from the sale of cocoyam.

Studies by Ajijola *et al.* (2003); Adepoju and Awodunmuyila (2008); Falola *et al.* (2014); Okoye *et al.* (2006) have also conducted profitability of cocoyam production enterprise in Nigeria. All these studies concluded that cocoyam production was profitable although there were notable differences in levels of profits made by cocoyam farmers. Gbigbi (2015) in a study exploring the commercial potential of cocoyam production concluded that cocoyam production was profitable with a return on investment of 81 percent. The study indicated that there are prospects for greater commercialization if sound policies are formulated to promote cultivation.

In Nigeria, Okoye *et al.* (2006) studied the cost and return analysis of cocoyam and found out that labour made up 50 percent of total variable cost of production, making it the most important production input in cocoyam enterprise. The study specifically adopted the gross margin procedure to examine profitability of cocoyam enterprises using data from 120 farmers. The study concluded that cocoyam enterprise was profitable with a 127 percent return on investment i.e. for any dollar invested into cocoyam production, a farmer receives $0.27 as profits. In Ajijola *et al.* (2003), the rate of return on cocoyam investment was found to be 147 percent.

Adepoju and Awodunmuyila (2008) also estimated cocoyam profitability in the Ekiti State of Nigeria. Gross margin analysis was the analytical technique employed for profitability assessment of respondents' production. The study showed that cocoyam production requires large initial capital to take off due to labour costs. However, it goes further to conclude that the returns that are made from the enterprise makes cocoyam cultivation a worthwhile investment. The study identified age, gender, marital status and farm size as having a relationship with cocoyam income.

A study by Falola *et al.* (2014) employed a couple of complementary analytical procedures to examine profitability of cocoyam production in addition to the ubiquitous gross margin approach. The study revealed that the gross value of output was estimated at $311.22 per hectare and an overall gross margin of $220.97 per hectare. In conclusion, the study found cocoyam production to be a profitable enterprise. The study further revealed that the operating ratio of the farmers was 0.29, signifying that operating expenses (variable costs) constituted 29 percent of gross income.

Most of the studies reviewed were, rather, silent on the contribution of revenue from cocoyam leaves to the total revenue accrued from cocoyam production. It was observed from the reviews that, cocoyam leaves were either bulked together with revenue from corms or totally ignored. This could result in an underestimation of the effective financial benefits that cocoyam farmers receive. Hence, this gap in knowledge regarding the contribution of cocoyam leaves to farm income. Again estimation of return on investment or asset for cocoyam in studies like Okoye *et al.* (2006) and Ajijola *et al.* (2003) seemed inaccurate given that profit from cocoyam production was compared to total production cost rather than the average total assets used in generating profit for the cocoyam enterprise. This could result in the overestimated return on investment.

Most of the studies reviewed ended their profitability analysis after estimating either gross margins or the net farm profit from production which according to Beattie (2015) is only a starting point of analysing profitability of farm enterprises. Unlike studies such as Chukwudji, 2008 and Kasiine and Okoje (2014) who found that the return on investment (asset) on plantain and cassava to be 12.6 and 23.6 percent respectively, information on the return on investment was scarce likewise literature on returns to critical resources like labour and land in cocoyam production. Further analysis by using any of the profitability or efficiency ratios like return on investment or equity or operating profit margins would give a clearer picture of profitability of cocoyam enterprises relative to assets used in generating the profit. In other words, information on how much can be made as profit when for every dollar (or Ghana cedi) invested in the enterprise is often not presented directly.

## 2.8 Constraints facing cocoyam producers

Several problems have been identified through empirical studies as constraints facing cocoyam production in Ghana. The existence of constraints in cocoyam production have varying implications on subsector especially on small scale cocoyam producers.

These constraints, according to Sagoe (2006) and Acheampong *et al.* (2014) contribute to the current low production of the crop and delimit the process of upgrading cocoyam value chain. Devendra (1993) holds the view that, constraints of production exert variable restrictions on the productivity and operational efficiency of small scale farmers. Constraints facing cocoyam producers bother on production (agronomic), marketing and socioeconomic issues. Quaye *et al.* (2010) in Ghana noted that high labour cost is the most important constraint for cocoyam producers in Ghana basically due to the labour-intensive nature of production especially with weed control and harvesting activities. The study also identified high cost of planting material, access to farm land (land acquisition problems), high transportation cost, lack of knowledge on improved varieties, incidence of diseases and limited access to credit for production as constraints facing cocoyam production in Ghana.

Sagoe (2006) explored the impact of climate change on root and tuber crops in Ghana and posits that poor soils and reducing rain days i.e. total rainfall, are impediments of cocoyam production. Unlike constraints already identified which may be within the control and management of farmers, others such as constraints related to climate change i.e. reducing total rainfall and declining forest frontiers due to land degradation, may be out of the direct control of producers. Zimdahl (2007) asserts that incidence of weeds cause economic losses to crops and hence requires the necessary actions to lessen their effects on crop production.

MoFA (2015) identifies the use of total chemical weed killers as an important production constraint. Incidence of weeds are known to be critical production constraint for cocoyam farmers. Total weed killers destroy weeds together with volunteer cocoyam which results in reduced sprouting rate. This points to poor agricultural practices by cocoyam producers partly as a result of lack of know-how on agrochemicals i.e. recommended chemical weed killers, application rates and methods (Sagoe, 2006). Again, because cocoyam is often cultivated as an intercrop, some producers tend to opt for herbicides or weedicides which will not affect the main crop but not necessarily cocoyam.

Acheampong *et al.* (2014), in an extensive study of the cocoyam value chain in Ghana cited the use of local varieties for planting, traditional practise of seed production and storage, limited bargaining power of farmers and minimal support from stakeholders (Government and Development Partners) as major bottlenecks. The study further identified declining soil fertility, high labour cost, high cost of transportation, poor road infrastructure, limited access to market and limited access to finance or credit also as major constraints.
The study specifically identifies the use of indigenous varieties for planting and lack of improved agronomic practises as the major constraints followed by poor road infrastructure and high input costs.

It must be indicated that, constraints facing cocoyam producers in Ghana are not so different from that of other producing countries according to available studies. Onyeka (2014) and Talwana *et al.* (2009) acknowledge that there is increasing trend of biotic constraint against cocoyam production. Onyeka (2014) identifies incidence of the Cocoyam Root Rot Disease (CRRD) locally known as 'jampoolo' as the main constraint affecting cocoyam production in the sub-region. Both studies point to the fact that this constraint is prevalent mainly because of the lack of adequate research on cocoyam diseases and prevention strategies and the lack of effective traditional disease control methods.

Serem *et al.* (2008) investigated the socio-economic constraints of cocoyam production across Uganda, Tanzania and Kenya and found that the major limiting factor against cocoyam production was land scarcity mainly due to the lack suitable lands for cultivation. The study also found challenges like diseases, weeds, pests, labour scarcity, lack of planting materials and improved varieties as the important constraints hampering the production of cocoyam.

In Nigeria, Ekunwe *et al.* (2015) studied the socio-economic determinants of cocoyam production among women farmers. The study identified unavailability of land and inadequate finance as the two major constraints affecting producers of cocoyam.

Cocoyam production is beset with a number of constraints which are biotic and abiotic. These constraints include production, marketing and other socio-economic issues. In conclusion, the most pertinent constraints hampering cocoyam production include lack or shortage suitable lands for production, high cost of labour, lack of credit or inadequacy of capital to invest, incidence of diseases and weeds, application of total weed killers and the lack of improved planting materials among others. These constraints can be resolved or managed to a large extent by stakeholders (producers, Government and para-statal institutions as well as Development Partners) and hence requires the utmost attention for a boost in cocoyam production in Ghana.

### 2.9 Conceptual Framework

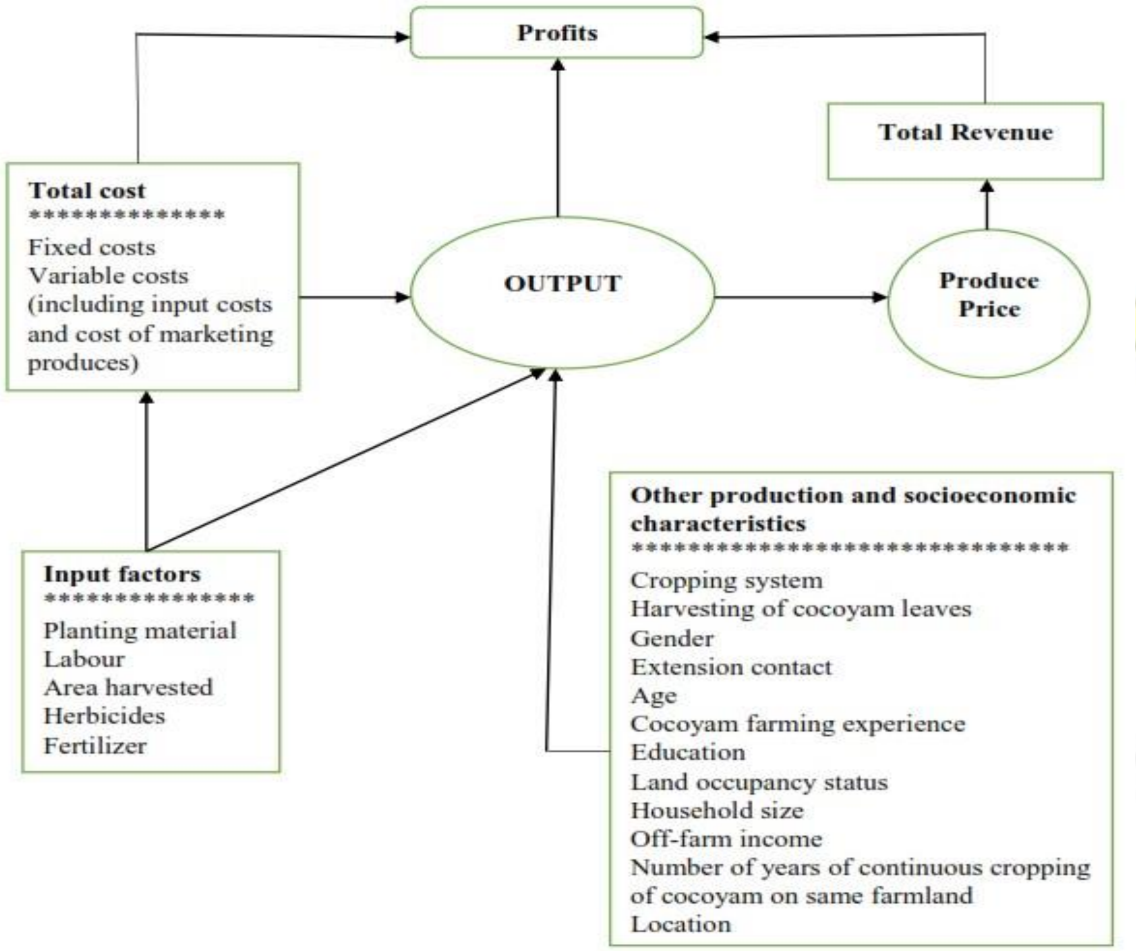
Generally, productivity and profitability are fundamental concepts in economics of agricultural production. These two concepts are not mutually exclusive of the other. Productivity is the ratio of total output to the resources employed during the production period whereas profitability is measured as the relationship between the levels of profits made during a production period and the level of resources used to make those profits (Barry *et al*., 1983). Profitability is influenced by the margins between costs and returns per unit of production and the number of units sold. This study conceptualises that, productivity leads to increased output and hence increased margins or profits, all things being equal.

The inputs factors; quantity of corm setts planted, labour, farm size and costs of other inputs used are considered to influence cocoyam output and hence the level of profitability. Socioeconomic factors like age, household size, farming experience and non-farm income are considered to influence cocoyam output hence the level of profitability. The market price of harvested produce and the cost of transportation are also known to strongly influence total revenue and hence, profits.

Furthermore, production factors like herbicide application and type of cropping system practised are also considered to affect cocoyam output and hence the level profitability. Other factors like agricultural land occupancy status, extension contact and location are also considered to influence cocoyam output or production and hence the level of profitability.

Figure 2.5 presents the conceptual framework for the study.

**Figure 2.5: Conceptual framework for the study**




Source: Author's Construct, 2015

## CHAPTER THREE

## 3.0 RESEARCH METHODOLOGY

### 3.1 Introduction

This chapter deals with a description of procedures and methods of analysis employed to answer the study objectives. The study adopted a two-step approach to analysis i.e. stochastic frontier analysis to identify determinants of production and profitability analysis to determine the market value and efficiency of converting investments in capital assets into profits by cocoyam producers. The chapter comprises the study area, research design, conceptual framework and analytical framework for analysing determinants and profitability of production and the hypotheses tested. It also details the data and sampling techniques employed.

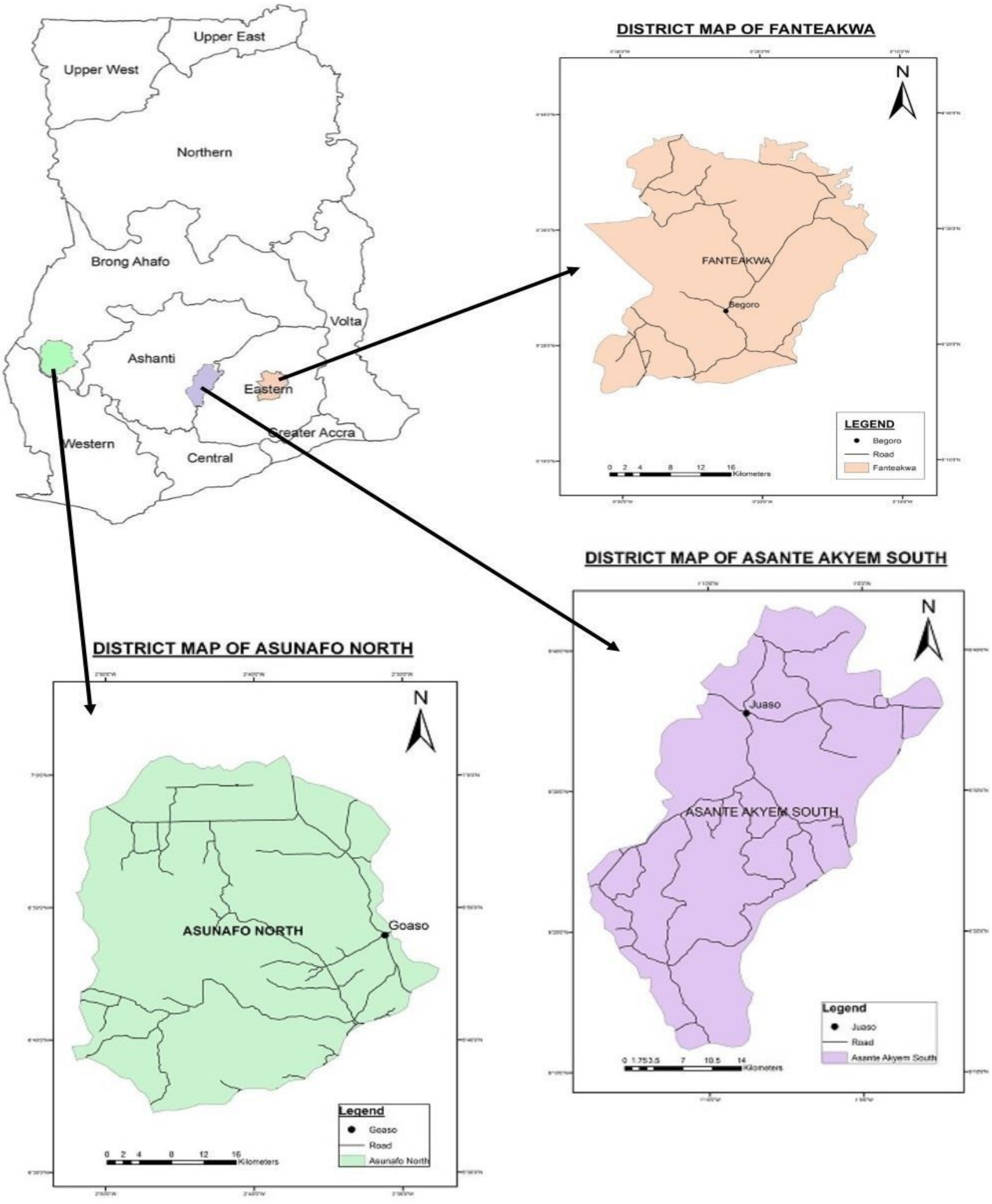
### 3.1 Study areas

This study was conducted in Asunafo North district in Brong Ahafo Region, the Asante Akyem South district in Ashanti Region and Fanteakwa district in the Eastern Region of Ghana. These districts are particularly known for cocoyam production in Ghana. Their respective capitals are Goaso, Juaso and Begoro. Figure 3.1 shows a map of Ghana indicating the location of the study districts.

#### 3.1.1 Asante Akyem North District

Asante Akyem South district (AAS_D) located strategically as the exit and locus of the Ashanti Region which falls within the forest agro-ecological zone of Ghana. Juaso is the district capital. The district is bordered on the South and West to the Eastern region of Ghana, on the North to Asante Akyem North district and to Bosome Freho, Amansie East, Ejisu Juabeng on the West. The district is administratively divided into 16 operational areas so as to facilitate the provision of extension services to farmers. Asante Akyem South district occupies a total area of 1,217.7sq km and it lies within the cocoa belt of Ghana.

**Figure 3.1 Map of Ghana showing study areas**




Source: Ghana Districts Repository (2015)

Asante Akyem South has a population of 140,694 with 51.9 percent being female. Agriculture is the most chief economic activity of the district with about 72 percent of the population involved in agriculture and the remaining involved rural industry and commerce (GSS, 2012). The district is mainly rural with majority of farmers being tenant farmers. The district has bimodal rainfall pattern characteristic of the forest areas of Ghana. The mean annual rainfall amount is between 1028mm and 1966mm which peaks between May and June and then in September and October. Major rivers like Anum, Pra, Kume are all located in this district. Nonetheless, these rivers have not been harnessed for irrigation yet. The weather and vegetation of this district makes it very suitable for the production of cocoyam. The commonest cash crops cultivated are cocoa, citrus, oil palm, coffee and food crops like cassava, plantain, cocoyam, rice, yam, maize and vegetables are also produced (www.ghanadistricts.com accessed on January, 2015; MoFA, 2015).

### 3.1.2 Asunafo North Municipality

Asunafo North district (AN_D) forms part of 22 districts/municipalities in the Brong Ahafo Region which also falls within the forest zone of Ghana. Its capital, Goaso, is located 85 kilometres away from Sunyani which is the regional capital. Land entitlement is entrusted in the chief who holds the land in trust. Even though individual families have the right to use parcels of land, they do not have authority to dispose them. Migrant farmers mostly obtain access to farmlands through land/crop lease agreements called Abunu" or "Abusa". The municipality covers a land area of 1,093.7sq km which is about 2.76 percent of the total land covered by the region. The municipality is located between latitudes 6° 27' N and 700 N and longitude 2.52°W. It borders Dormaa municipality to the North West, Juaboso-Bia and SefwiWiaso District in the Western Region to the South West, Asutifi district in the North-East and Asunafo South district in the Brong Ahafo Region to the South-East (www.ghanadistricts.com accessed on January, 2015).

Mean temperature of the district is about 25.5°C all year round but March normally records the highest mean temperature of 30°C. The district benefits from a double maxima rainfall pattern. The mean annual rainfall ranges from 1250mm to 1750mm. The major rains fall between April and July whereas the minor rains occur between September and October. Relative humidity of the district is highest during the wet season ranging between 75 percent and 80 percent while the dry season gives the lowest range between 20 – 35 percent.

The forest of the district are semi-deciduous in nature and it occupies about 578.63 kilometres squared (MoFA, 2015). Similarly, the weather conditions and vegetation of the district is very suitable for the production of cocoyam.

The district has a total population of 124,685 with 50.4 percent being males (GSS, 2012). About 81 percent of farmers in the district practise the mixed cropping system. Farmers involved in plantation farming constitute 15 percent while only 4 percent practise mono-cropping. Arable cropping is commonly integrated with cocoyam and plantain which are used for temporal shade for cocoa which continues to be the permanent occupant of farmlands. Farmlands are sometimes left to fallow for re-growth into secondary forest. Cocoa and principal food crops like plantain, cocoyam, rice, maize and cassava are crops commonly grown in the municipality. Other cash crops planted include oil palm, cocoa, coffee, citrus, ginger, avocado, sugar cane, pineapple, okra, pepper, cabbage, carrots etc. (MoFA, 2015).

### 3.1.3 Fanteakwa District

Fanteakwa lies within longitudes 0° 10 East and latitudes 6° 15' North and 6° 40' West. It is one of the 26 districts and municipalities in the Eastern Region which also falls within the agroecological zone of Ghana. The district is considered to be located exactly in the middle of the region. The district shares boundaries with the Volta Lake on the North, Manya Krobo on the East, Kwahu South district on the North West, East Akyem district on the South West, and Yilo Krobo on South East. Fanteakwa covers a total land area of about 1,150sq km with about 761.33sq km of the total landmass being agricultural land. According to GSS (2012), the district has a total population of 108,614 of which majority (50.2 percent) are female. The vegetation is made up of the semi deciduous rain forest however, the northern parts of the district consist of savanna shrubs. The district contains a land mass of 291.42sq km of forest reserve. These include Worobong Forest Reserve, Southern Scarp Reserve and Bisaa-Dede Forest Reserves (www.ghanadistricts.com accessed on January, 2015).

Fanteakwa shares similar weather conditions and vegetation with Asante Akyem Akyem South and Asunafo North Districts. The district enjoys a bi-modal rainfall pattern with a mean annual rainfall between 1500 and 2000mm making it suitable to produce cocoyam. Commonest crops cultivated in the district aside cocoyam are; plantain, maize, cassava, yam and vegetables but the district is considered the largest commercial producer of cocoyam in Ghana. The mean farm size in this district is about one hectare.

Some producers in this district benefit from irrigation schemes operating along the Volta basin at Nakpanya, Petefour, Adakofe and Dedeso (MoFA, 2015). Cocoyam production information specifically for the districts under study were not readily available but Table 3.1 provides cocoyam production information for the three major producing regions to which the study districts belong.

**Table 3.1 Cocoyam production statistics for Ashanti, Brong Ahafo and Eastern regions**

| Year | Average r l production levels (metric | | |
|---|---|---|---|
| | **Ashanti** | **Brong Ahafo** | **Eastern** |
| 2000 | 633,498 | 372,845 | 274,599 |
| 2001 | 671,415 | 392,720 | 276,422 |
| 2002 | 701,304 | 402,563 | 350,426 |
| 2003 | 673,056 | 412,407 | 350,244 |
| 2004 | 642,802 | 436,281 | 360,080 |
| 2005 | 532,340 | 416,049 | 363,915 |
| 2006 | 520,121 | 407,847 | 355,713 |
| 2007 | 527,966 | 407,654 | 379,588 |
| 2008 | 517,763 | 405,482 | 369,391 |
| 2009 | 425,350 | 353,169 | 333,123 |
| 2010 | 401,097 | 250,735 | 332,926 |
| 2011 | 380,876 | 252,554 | 330,750 |

Source: extracted from Acheampong *et al.* (2014).

### 3.2 Type and sources of data

Analysis was based on primary data sourced from cocoyam producers in the study districts. The data comprised of both social (age, farming experience, education, household size etc.) and economic data (farm income, non-farm income, cost of production, level of inputs use etc.). Secondary sources of data were sourced especially from published periodicals and reports on crop production in Ghana from MoFA; FAO (FAOSTAT) and recent peer-reviewed journals.

### 3.3 Population, sample size and sampling procedure

The target population for this study was cocoyam producers in the study area. A mixed sampling technique was adopted for this study. The study districts were purposively selected from the three regions as they are considered to be the highest producing districts for cocoyam in Ghana.

The districts are; Asunafo North municipality in the Brong Ahafo, Asante-Akyem South in the Ashanti Region and Fanteakwa district in the Eastern Region. A two-stage sampling technique was employed to select the respondents from the study districts. First, five communities were selected from each of the three districts using a simple random sampling technique. With the help of the MoFA directorates within the aforementioned districts, all the cocoyam producing communities were listed followed by a random selection of five communities in each district from the list through balloting.

Secondly, ten cocoyam producers were subsequently selected from each of the fifteen communities through simple random sampling technique. The list of cocoyam producers in these communities was obtained through the assistance of agricultural extension agents assigned to the selected communities. The essence of the random sampling was to ensure that each unit (farmer) has an equal probability of being selected thereby ensuring a highly representative sample and reducing human bias. In all, a total of 150 cocoyam producers were sampled and interviewed from 15 communities in the three districts as shown by Table 3.2.

**Table 3.2: Selected communities used for the study**

| **Asante Akyem South** | | **Asunafo North** | | **Fanteakwa** | |
|---|---|---|---|---|---|
| Community | No. | Community | No. | Community | No. |
| Amoakrom | 10 | Atimponya | 10 | Asare Kwao | 10 |
| Koikrom | 10 | Duase | 10 | Ayigbe Town | 10 |
| Sabo | 10 | Gyaenkontabuo | 10 | Feyiase | 10 |
| Komeso | 10 | Akrodie | 10 | Mianya | 10 |
| Banso | 10 | Ayomso | 10 | Dominase | 10 |
| Total | 50 | Total | 50 | Total | 50 |

Source: Field Survey, (2015)

### 3.4 Method of data collection

Information was elicited from cocoyam producers through interviews with the aid of structured questionnaires. Information obtained include; variables on the socio-economic characteristics of the cocoyam farmers, production variables such as inputs used in cocoyam production, sources and quantities of these inputs, cost and returns and also data on production constraints.

## 3.5 Analytical framework

Descriptive statistics such as arithmetic means, percentages and frequency distributions, charts and tables were employed to analyse the socio-economic characteristics, land area under cocoyam cultivation, and output/yield from the study districts. Determinants of cocoyam production was assessed by estimating a stochastic production frontier model. Profitability of cocoyam production was examined using Gross Margin Analysis to determine the financial cost and returns associated with cocoyam production. Further analysis on return on investment (ROI) on cocoyam production per hectare was also determined. Finally, identification, ranking and analysis of major constraints militating against cocoyam production were analysed.

Krippendorff's Alpha Reliability Test was used to examine the level of concordance or reliability of responses among farmers.

### 3.5.1 Gross margin analysis

Gross Margin Analysis was conducted in order to determine the market value of cocoyam (corms and leaves). Olukosi and Erhabor (1988) defined gross margin as the difference between the total revenue and the total variable cost. More recently, Kay *et al.* (2004) also stated that gross margin is the difference between income and variable costs.

Mathematically, it is expressed as:

*Gross Margin (GM) = Total Revenue (TR) – Total Variable Cost (TVC)* (3.1a)

i.e.

$$GM = \sum_{j=1}^{m} P_j Y_j - \sum_{i=1}^{n} P_i X_i \quad (3.1b)$$

Where;

$P_j$ denotes the market price per unit of output, $Y_j$ denotes the quantity of output. $X_i$ and $P_i$ denote quantity of variable inputs used in cocoyam production and price of each variable input respectively whereas *i, j… n, m* represent the total sample size.

Depreciation on farm assets were imputed as part of cost of production per production season. Depreciation was defined as the reduction in economic value of a farm asset over a period of time. Operationally, the cost of depreciation of a farm asset was defined as the cost of the asset spread over its useful economic life. In this study, only a few assets were considered for depreciation since most of the assets or inputs employed lasted at most a year. Depreciation was imputed on farm assets like knap-sack sprayer, hoes and metal basins since their average useful life stretched beyond a year. The straight line depreciation method was used and it is expressed as;

$$\text{Annual depreciation} = \frac{\text{Assetcost - Salvage Value}}{\text{Years of useful life}} \quad (3.2a)$$

The study further assumed based on observations on the field that, such farm assets had zero economic value after their useful years. In other words, in the computation of depreciation, the farm assets were assumed to have no salvage value. Hence, the operational expression for depreciating farm assets was;

$$\text{Annual depreciation} = \frac{\text{Assetcost}}{\text{Years of useful life}} \quad (3.2b)$$

Furthermore, the net farm profit was computed to know how much is returned to cocoyam producers after marketing their produces. Net farm income (NFI), also known as net farm profit, reflects the revenue left after adjusting for fixed costs like rent on land, cost of equipment and depreciation. In other words, net farm income was computed using the formula;

$$NFI = \sum_{i=1}^{n} \text{Gross Margin}_i - \text{Total Fixed Cost}_i \quad (3.3)$$

Finally, return on asset/investment was computed to ascertain the profitability or the effectiveness in producing profit from capital invested by cocoyam producers or entrepreneurs in the study districts. ROI is the percentage return on (equity and debt) capital investment (Kohl and Wilson 1997). It was defined as a ratio of net farm income or profit adjusted by interest expenses and opportunity cost for unpaid labour and management relative to the total farm investment (average cost of assets). Mathematically, ROI is expressed as;

$n$ *Returnsto assets*

Rate of return on Investment(ROI)= $\sum_{i=1}$ ―――――――――― *Averagetotal assets* %

(3.4)

Returns to asset was computed as the net farm income less the value of operator labour and management. Slight modifications were done in estimating the returns to assets. The adjustment for loan interest was not necessary here because small scale cocoyam producers financed their production through equity capital. It is worth noting that, opportunity costs were factored into the calculation of the costs and returns during the 2014/2015 production season. The returns were calculated based on both in-kind revenue and sales revenue received from cocoyam. Cocoyam harvested and consumed by the producers' household or gifted to others were considered in-kind revenue from production, hence included as part of revenue from the cocoyam enterprise for the production year. In the same manner owner inputs like farmers' own corm setts used for planting and any other input which was not directly purchased by farmer as well as family labour and management were considered based on the actual market prices and included as costs incurred for the production year.

Furthermore, all standard production costs used for estimations and generating income statements were based on the average fair market value of the cost items for the 2014/2015 cropping season. The data included costs for corms used for planting, labour, fertilizer and weedicides (if any), marketing cost etc. Income statements that were generated therefore represent the average cocoyam farm per district or per cropping system.

Given the reality of complexity in determining the level of resource use when dealing with one crop within an intercropping system, estimations and apportioning of labour, land and other resources were done solely based on the proportion of land that was covered by cocoyam. Under the intercropping system, respondents were asked to indicate what proportion of their intercropped land had been allocated to cocoyam. Resources applied and costs incurred to the whole farm were captured. Subsequently, resources applied and costs incurred specifically to cocoyam cultivation was derived based on the proportion that cocoyam covers on the intercropped land.

Following the principles of evaluation of farm systems by McConnell and Dillon (1997) further analysis of returns to land and operator labour and management was conducted using the formulae:

$$Return\ to\ labour\ and\ mgt = NFI - Opportunity\ cost\ of\ capital \quad (3.5)$$

$$Return\ to\ land = NFI - opp\ cost\ of\ capital\ less\ land - opp\ cost\ of\ labour\ and\ mgt \quad (3.6)$$

The opportunity cost of capital was estimated using the prevailing cost of capital in the economy i.e. 25 percent according to the Bank of Ghana (BoG, 2016). Analysis focussed on the return to family labour and management of producers instead of the disaggregated returns on labour and returns on management. This was because cocoyam production is typically a small scale agricultural enterprise and management is so closely interlinked with family labour. Therefore distinguishing between family labour and management in the case of small farms is practically difficult to do (McConnell and Dillon, 1997).

### 3.5.2 Cocoyam production constraints analysis

For the purposes of detailed analysis, constraints of production were rated using a 5-point Likert scale. Cocoyam producers judged constraint statements using a scale: 'strongly agree' = 5; 'agree' = 4; 'neutral/indifferent' = 3; 'disagree' = 2 and 'strongly disagree'=1. The study further used the Krippendorff's Alpha Reliability Test to examine the level of agreement in responses. Krippendorff's alpha (α) is another type of reliability coefficient developed to measure the level of agreement among coders, judges, observers, raters or measuring instruments drawing differences among normally unstructured phenomena or allot computable values to them (Krippendorff, 2012). The general formula for the test is;

$$\alpha = 1 - \frac{D_o}{D_e} = 1 - \frac{\sum_{u=1}^{N} \frac{m_u}{n} D_u}{D_e} = 1 - \frac{D_{within\ units\ in\ error}}{D_{within\ and\ between\ units\ in\ total}} \quad (3.7)$$

Where;

$\alpha$ is the alpha statistic; $D_o$ and $D_e$ are observed and expected disagreements respectively, among values assigned to constraints; $M$ is the number of farmers (judges); $N$ is the number of attributes to be judged (ranked). This approach in assessing the extent of agreement by judges (farmers) to identified or stated attributes is relatively new but preferred to other reliability tests due to its obvious ability to fit nominal, ordinal, interval or ratio, circular and polar values of increasing complexity regardless of the number of observers as well as incomplete data. Studies that have applied this approach include Rinderer *et al*. (2015); Gutman *et al*. (2013); Burnap *et al*. (2013); Hayes and Krippendorf (2007) and Neuendorf (2002).

The following hypothesis was tested for the potential constraints:

$H_0: \gamma = 0$ : There is no agreement on the constraints faced by cocoyam producers.

$H_1: \gamma \neq 0$ : There is significant agreement on the constraints faced cocoyam producers.

For reliability considerations, $\alpha$ ranges from $1 \geq \alpha \geq 0$ $\alpha = 1$ indicates perfect agreement or reliability $\alpha = 0$ indicates the absence of agreement or reliability i.e. values assigned to attributes are statistically unrelated

$\alpha < 0$ when disagreements are systematic and exceed what can be expected by chance (Krippendorff, 2012).

According to Landis and Koch (1977) when $\alpha<0$, it indicates ``poor or no" agreement, $\alpha = 0 – 0.2$ means “slight" agreement; $\alpha = 0.21 – 0.40$ indicates a “fair” agreement, $\alpha = 0.41 – 0.60$ means “moderate" agreement while $\alpha = 0.61 - 0.80$ also indicates “substantial" agreement. Lastly, $\alpha = 0.81 – 1$ implies a “near perfect" agreement.

Based on literature reviews and initial reconnaissance survey by researcher, a pool of constraints were identified and a matrix was subsequently developed into three basic categories (based on their roles or effect on production) namely;

1. Production constraints: high incidence of weeds, pests and diseases, low soil fertility, excessive application of chemicals, non-availability of chemicals and fertilizers, shortage of planting materials, declining soil fertility, lack of cultivable land for expansion, high labour intensity, labour scarcity and high cost of labour.
2. Marketing constraints: poor road infrastructure, unpredictable market prices for corms and leaves, lack of ready market, low produce price, unstable market prices and high cost of transportation.
3. Socio-economic-cultural constraints: limited access to credit, high perishability of cocoyam leaves lack/inadequate capital (credit) to invest in production, high interest rates on available credit.

### 3.5.3. Empirical model specification for determinants of cocoyam production

The two stochastic production functions were estimated and the best fit model was selected by conducting the Likelihood Ratio (LR) test. The stochastic Cobb Douglas and translog productions frontier functions that were used in this study are explicitly represented as:

Translog form:

$$\ln Y_i = \beta_0 + \sum_{i=1}^{19} \beta_i \ln X_{ij} + \frac{1}{2}\sum_{i=1}^{19}\sum_{k=1}^{19} \beta_{jk} \ln X_{ij} \ln X_{ki} + v_i - u_i \quad (3.8)$$

Cobb Douglas form (double log):

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \ldots\ldots + \beta_{19} \ln X_{19} + v_i - u_i \quad (3.9)$$

Where;

$Y$ is output of cocoyam (kg/ha); $v_i$ and $u_i$ are the stochastic and normal noise terms of the model respectively. The specific explanatory variables are specified in Table 3.2. In order to determine the best fit model for the data the likelihood ratio test was performed. The specified Cobb Douglas production model represented the restricted model whereas the specified translog production model represented the unrestricted model (Pascoe *et al.*, 2003).

The generalized LR test statistic (λ) was estimated to determine the relevance of the restrictions. The LR test is given by:

$$\lambda = -2\left[\ln\{L(H_0)\} - \ln\{L(H_1)\}\right] \quad (3.10)$$

Where; $\ln\{L(H_o)\}$ and $\ln\{L(H_1)\}$ are the log-likelihood function values for the null ($H_o$) and alternative ($H_1$) hypotheses respectively. The restricted model (Cobb Douglas) form the basis of the null hypothesis, whereas the unrestricted model (translog) is the alternative hypothesis. The value of LR test statistic (λ) has a $\chi^2$ distribution with the degrees of freedom being the total number of restrictions introduced (Pascoe *et al.*, 2003). Besides the outcome of the LR test, other factors were considered in selecting the best fit model. These include number of significant variables, algebraic signs of coefficients of parameters and reasonableness of estimated parameters (Hussain *et al.*, 2000). From the above statistical procedures, the Cobb Douglas production function was selected and subsequent analysis were based on it. Table 3.3 presents a summary of *apriori* expectations of all explanatory variables of the model.



**Table 3.3 *Apriori* expectation of explanatory variables of the model**

| Variable | Explanation of variable | Measurement | Hypothesized effects |
|---|---|---|---|
| $X_1$ | Planting material used | Kilograms per hectare | + |
| $X_2$ | Labour | Man days | + |
| $X_3$ | Area cultivated | Hectares | + |
| $X_4$ | Other costs (fertilizer and fungicides) | GH¢ | + |
| $X_5$ | Cropping system | Dummy (1=mono; 0=otherwise) | + |
| $X_6$ | Gender | Dummy (1=male; 0=otherwise) | +/- |
| $X_7$ | Leaves harvested | Kilograms per hectare | - |
| $X_8$ | Extension contact | Number of visits per year | + |
| $X_9$ | Age of farmer | Years | +/- |
| $X_{10}$ | Herbicide usage | Dummy (1=yes; 0=otherwise) | - |
| $X_{11}$ | Education | Years of formal education | + |
| $X_{12}$ | Household size | Number of people | + |
| $X_{13}$ | Land occupancy | Dummy (1=owned; 0=otherwise) | +/- |
| $X_{14}$ | Off-farm income | GH¢ | + |
| $X_{15}$ | Farming experience | Number of years in cocoyam farming | + |
| $X_{16}$ | Years of continuous cropping | Number of years of continuous cropping | - |
| $X_{17}$ | Volunteer proportion | Percentage | +/- |
| $X_{18}$ | Location1 (Asunafo North) | Dummy (1=yes; 0=otherwise) | +/- |
| $X_{19}$ | Location2 (Asante Akyem South) | Dummy (1=yes; 0=otherwise) | +/- |

**3.5.4 Further description of some variables used in the stochastic production model**

Labour ($X_2$) was defined as total man-days employed by the *i*-th producer on their cocoyam farm during the 2014/2015 production year.

Family labour or hired labour was therefore measured as the number of man-days spent by either of the two per activity from land clearing to harvesting and marketing. One man day for labour was calculated as one adult male working for eight hours. However, one female and one child (less than 18 years) working for eight hours equalled 0.75 and 0.5 man days respectively according to Coelli and Battese (1996).

Area cultivated ($X_3$) was defined as the total hectares (ha) used for cocoyam cultivation *i*-th farmer for the 2014/2015 production season. Total land area under cultivation for cocoyam under mixed cropping systems was estimated as the proportion of total farm area that cocoyam covers in order to derive the actual cocoyam farm size.

Cropping system ($X_5$) was measured as a binary variable (dummy) and it was used to capture the effect of cropping systems on the output of corms for the 2014/2015 production year. A score of 1 was given if a farmer cultivated cocoyam as a pure stand or monocrop on a piece of land and 0 if farmer cultivated the root crop as an intercrop.

Herbicide usage ($X_{10}$) was also measured as a dummy and it was used to capture the effect of herbicide application on the output of corms for the 2014/2015 production year. A score of 1 was given if a farmer applied some form of herbicide to his/her cocoyam farm and 0 if farmer did not apply herbicide to their cocoyam farm at all.

Household size ($X_{12}$) was measured as the number of people living together as a unit and eat from the bowl and it includes adult men, women and children.

Volunteer proportion ($X_{17}$) was measured as a percentage. It indicated the proportion of volunteer cocoyam relative to proportion of corm setts that was intentionally planted for the 2014/2015 production season by the *i*-th farmer.

$X_{18}$ and $X_{19}$ are variables that were introduced to investigate location effects on corm production. These are dummy variables and 1 was assigned consecutively to *i*-th cocoyam producer from Asante Akyem South and Asunafo North districts. 0 was assigned to producers who were not from the respective districts. Fanteakwa district was used as the reference variable for location.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1 Introduction

This chapter presents all results and discussions based on the specific objectives of the study. It covers output levels and factors of production for cocoyam cultivation. The chapter also discusses profitability and analyses of constraints for cocoyam producers within the specific districts and the pooled data as well. Results from all hypotheses that were tested have also been presented.

## 4.2 Demographic characteristics of cocoyam producers

Table 4.1 presents socio-economic and production characteristics of the cocoyam producers in the three districts.

### 4.2.1 Gender

Results showed that majority of the cocoyam producers (56 percent) were females whereas 44 percent of them were males; suggesting that cocoyam production is a woman’s enterprise. Most producers from the Asante Akyem South district were female (58 percent). However, in the Fanteakwa district, 78 percent of the respondents were male producers, consistent with work done by Quaye *et al*, (2010) who found that majority of cocoyam farmers in that district were males. In the Asunafo North districts, the number of male producers were the same as the number of female respondents interviewed. The results resonate with the assertion that cocoyam is a women’s crop as more women are involved in its production than men (Ijioma *et al*. 2014 and Ikwelle *et al*. 2003). On the other hand, the higher involvement of men in cocoyam production in the Fanteakwa district, could be due to the higher commercial value associated with cocoyam within the district as posited by Talwana *et al*. (2009). Unlike male farmers in Asunafo North and Asante Akyem South who are exposed to cultivation to the cash crops like cocoa and so leave the cultivation of cocoyam to females, male farmers in Fanteakwa cultivate cocoyam as a major cash crop hence their significant involvement relative to the other producing districts.

### 4.2.2 Age

On the whole, cocoyam producers were mostly above 30 years. Only eight percent of the respondents fell below 30 years. However, about 43 percent of the respondents were above 50 years suggesting that cocoyam farmers are relatively old but active.

Furthermore, 36 percent of respondents were between the ages of 41 and 50 years whereas 13 percent or respondents were between the ages of 31 and 40 years. Averagely, a typical cocoyam farmers was about 48 years old (Table 4.2). Results compare favourably with Quaye *et al.* (2010) who found the average age of cocoyam producers to be 43 years. However, a baseline report on roots and tuber crops production for WAAPP done by Sam and Dapaah (2009) reported a relatively lower mean age of 36 years for cocoyam producers.

**Table 4.1: Demographic characteristics of cocoyam producers**

| **Variable** | **Asante Akyem** | | **Asunafo** | | **Fanteakwa** | | **Pooled** | |
|---|---|---|---|---|---|---|---|---|
| | **FreqSouth** | **%** | **FreqNorth** | **%** | **Freq** | **%** | **Freq** | **%** |
| **Gender** | | | | | | | | |
| Male | 21 | 42 | 25 | 50 | 38 | 78 | 66 | 44 |
| Female | 29 | 58 | 25 | 50 | 12 | 24 | 84 | 56 |
| **Age** | | | | | | | | |
| 20 to 30 years | 6 | 12 | 5 | 10 | 1 | 2 | 12 | 8 |
| 31 to 40 years | 4 | 8 | 10 | 20 | 6 | 12 | 20 | 13.3 |
| 41 to 50 years | 25 | 50 | 13 | 26 | 16 | 32 | 54 | 36 |
| Above 50 years | 15 | 30 | 22 | 44 | 27 | 54 | 64 | 42.7 |
| **Educational status** None | 4 | 8 | 20 | 40 | 14 | 28 | 38 | 25.3 |
| Basic/Non-formal | 43 | 86 | 29 | 58 | 28 | 56 | 100 | 66.7 |
| Secondary/pre-tertiary | 3 | 6 | 1 | 2 | 8 | 16 | 12 | 8 |
| **Marital status** Single | 4 | 8 | 2 | 4 | - | | 6 | 4 |
| Married | 43 | 86 | 43 | 86 | 45 | 90 | 131 | 87.3 |
| Widowed | 3 | 6 | 1 | 2 | 4 | 8 | 5 | 3.3 |
| Divorced/separated | - | | 1 | 2 | 4 | 8 | 5 | 3.3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Land occupancy status** Own land/inherited | 31 | 62 | 29 | 58 | 21 | 42 | 81 | 54 |
| Family/stool land | 7 | 14 | 5 | 10 | 6 | 12 | 18 | 12 |
| Rented | 6 | 12 | - | | 11 | 22 | 17 | 11.3 |
| Sharecropping | 6 | 12 | 16 | 32 | 7 | 14 | 29 | 19.3 |
| Other (government lands, forest reserves) | - | | - | | 5 | 10 | 5 150 | 3.3 |
| Total (N ) | 50 | | 50 | | 50 | | | |

Source: Field Survey, 2015

**Table 4.2: Descriptive statistics of socioeconomic characteristics of cocoyam producers**

| Variable | | Minimum | Maximum | Mean | Std. Dev. | CV (%)[a] |
|---|---|---|---|---|---|---|
| Age (years) | AAS | 20 | 67 | 44.86 | 9.83 | 21.91 |
| | AN_D | 22 | 73 | 49.24 | 13.59 | 27.6 |
| | F_D | 30 | 70 | 50.24 | 9.78 | 19.47 |
| | Pooled | 20 | 73 | 48 | 11.5 | 23.96 |
| Years in formal education | AAS | 4 | 15 | 9.20 | 2.57 | 27.93 |
| | AN_D | 2 | 12 | 8.07 | 2.73 | 33.83 |
| | F_D | 3 | 15 | 9.34 | 2.76 | 29.55 |
| | Pooled | 2 | 15 | 8.92 | 2.71 | 30.38 |
| Household size | AAS | 1 | 12 | 6.04 | 2.43 | 40.23 |
| | AN_D | 1 | 15 | 6.67 | 3.52 | 52.77 |
| | F_D | 1 | 20 | 7.73 | 2.65 | 34.28 |
| | Pooled | 1 | 20 | 6.85 | 3.01 | 43.94 |
| Cocoyam farming experience (years) | AAS | 2 | 30 | 9.57 | 8.24 | 86.1 |
| | AN_D | 2 | 53 | 16.69 | 13 | 77.89 |
| | F_D | 2 | 50 | 19.76 | 11.40 | 57.69 |
| | Pooled | 2 | 53 | 15.31 | 11.84 | 77.34 |

N (Pooled) =150; N(AAS) = 50; N(AN_D) = 50; N(F_D) = 50

[a] Coefficient of variation (CV) is a measure of relative dispersion calculated by expressing standard deviation (SD) as a percentage of the mean (X) i.e. $CV = SD/\bar{X}$

Source: Author's Computation, 2015

About 30 percent of cocoyam producers from Asunafo North were below 41 years compared to 20 percent and 14 percent of young farmers from Asante Akyem South and Fanteakwa districts respectively. The cocoyam producers in Asante Akyem South were relatively young. The average ages of farmers in the Fanteakwa, Asunafo North and Asante Akyem South districts were 50 years, 49 years and 45 years respectively (Table 4.2). Since majority of the respondents were above 30 years, it implies that respondents are active and more likely to make use of agricultural innovation and technologies (Azeez and Madukwe, 2010; Polson and Spencer, 1991).

### 4.2.3 Educational status

At least 75 percent of respondents had attained some form of basic level or non-formal education while 25 percent of the cocoyam producers interviewed had not had any form of education whatsoever. However, close to 68 percent had up to basic level of education whereas eight percent of respondents had attained secondary or pre-tertiary level of education.
On the whole, a cocoyam producer had attained an average of nine years in formal education. This means that a typical cocoyam farmer had completed at least the Junior High School (Table 4.2). Table 4.1 further shows that respondents from Asante Akyem South appeared relatively more educated (92 percent) than respondents from Fanteakwa (72 percent) and Asunafo North (60 percent) districts respectively. The average number of years in formal education for Fanteakwa and Asante Akyem South farmers were nine years and an average of eight years of formal education for farmers in the Asunafo North district of Ghana (Table 4.2). Similarly, Sam and Dapaah (2009) found that 29 percent of cocoyam producers had no formal education. The results suggest a low level of literacy since farmers at that level can barely read nor write. Low literacy rate of farmers is barrier to innovation and technology transfer (Jegede, 2008). Technology dissemination should therefore be targeted and done in the local language.

### 4.2.4 Marital status and household size

Table 4.1 shows that majority, representing 87 percent, of the cocoyam producers interviewed were married. Only four and three percent were single and divorced or separated respectively. Similar results is observed within districts with 86 percent (each) and 90 percent of respondents from Asante Akyem South, Asunafo North and Fanteakwa respectively, being married.

Furthermore, from Table 4.2, cocoyam farming households constituted an average of seven members per household. The average household size of cocoyam producers in the Fanteakwa and Asunafo North districts were seven whereas the average household size for farmers in the Asante Akyem district was six. This suggests that, all things being equal, respondents have access to household labour thereby reducing the operational cost of production as indicated by Adepoju and Awodunmuyila (2008).

### 4.2.5 Land occupancy status

More than half, (54 percent) of the farmers interviewed either owned farmlands or had inherited the farmlands on which cocoyam was cultivated. About 12 percent produced cocoyam on rented farmlands while 11 percent of respondents were cultivating on family or stool lands. Farmers handling sharecropped farmlands represented only 19 percent. Other forms of land occupancy represented three percent. Farmers who cultivate cocoyam on family or stool lands, rented lands and sharecropped lands had limited control over such lands whereas cocoyam producers who owned or had inherited their farmlands had full control.

Sharecropping land tenure system was more predominant in the Asunafo North and Fanteakwa districts with 32 percent and 14 percent respectively compared to Asante Akyem South. In Asante Akyem South, 62 percent owned farmlands under cocoyam cultivation. About 14 percent cultivated on family or stool lands whereas 12 percent produced cocoyam on rented farmlands. In Asunafo North, 58 percent owned the farmlands under cocoyam cultivation whereas 10 percent were cultivating cocoyam on family or stool lands.

Some farmers from the Fanteakwa district had special but controlled access to certain lands and secondary forest reserves under government control. This represented 10 percent of the total land ownership status from the district. Aside that, 22 percent of the cocoyam producers from the district were using rented farmlands to grow cocoyam. This highlights the apparent scarcity of land for cocoyam cultivation in the Fanteakwa district. About 42 percent of producers from the Fanteakwa district were farming on own lands. Apart from cocoyam producers in Fanteakwa, farmers who usually used rented lands for cocoyam production primarily did so for cocoa production. Cocoyam and plantains are then used as shade crops for the cocoa plants until the cocoa plants form their own canopy.

### 4.2.6 Farm experience for cocoyam production

Table 4.2 also shows that on the average farmers had been cultivating cocoyam for 15 years. Cocoyam farming experience of respondents ranged from two years to over 53 years. Fanteakwa cocoyam farmers had an average farming experience of 20 years which is highest compared to 17 years of cocoyam farming experience and 10 years of cocoyam farming experience for Asunafo North and Asante Akyem South districts respectively.

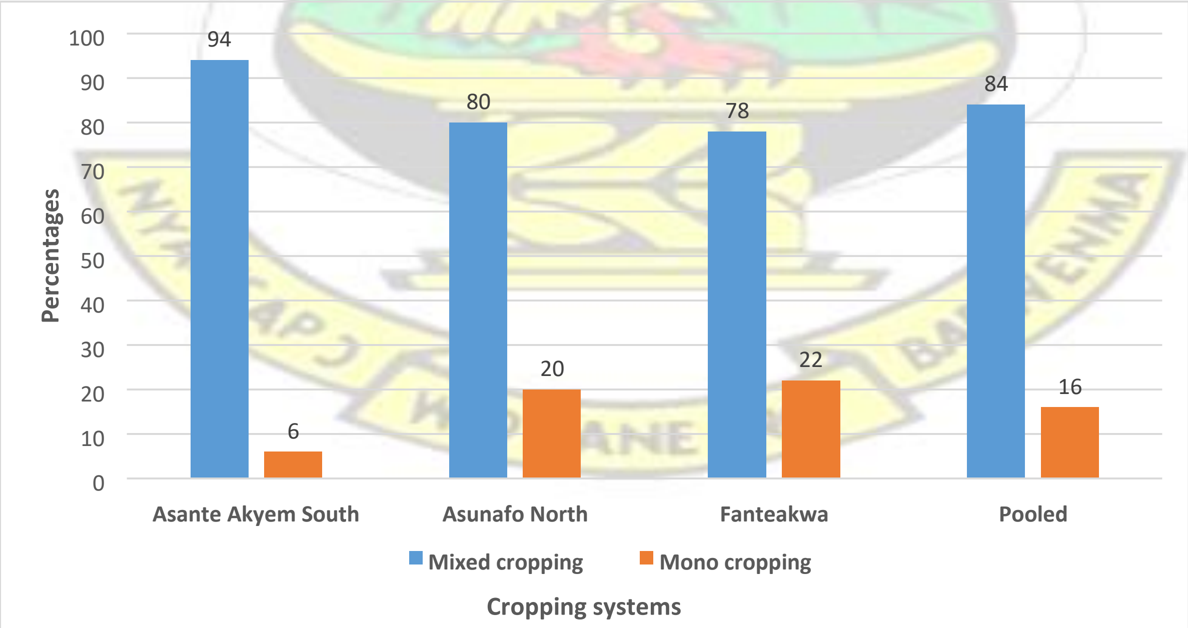
### 4.2.7 Other production characteristics of producers in study districts

#### 4.2.7.1 Cropping systems practised by cocoyam producers

Figure 4.1 shows that the cropping system commonly practised by cocoyam farmers is mixed cropping. Majority representing 84 percent of cocoyam producers cultivated cocoyam as an intercrop with other crops in varying proportions while 16 percent of the respondents cultivated the root crop as pure stand In Asante Akyem South, 94 percent of the cocoyam farmers intercropped cocoyam with other crops such as cocoa, plantain and cassava on the same piece of land whereas 80 percent and 78 percent of respondents from Asunafo North and Fanteakwa respectively also cultivated cocoyam as an intercrop.

This result indicates an improvement in production intensity from the findings of Quaye *et al*, (2010) where no cocoyam farms were found under intensive crop management systems. Cocoyam producers who cultivated cocoyam as pure stand were more common in Fanteakwa and Asunafo North districts in order of importance. About 22 percent of cocoyam producers in the Fanteakwa district cultivated cocoyam as a sole crop compared to ten percent of the producers from Asunafo North. Only six percent (representing the least) cocoyam farmers from Asante Akyem South planted cocoyam as sole crop. Figure 4.2 present a graphical summary of the cropping systems for the various districts.

**Figure 4.1 Cropping systems practised on cocoyam farms**



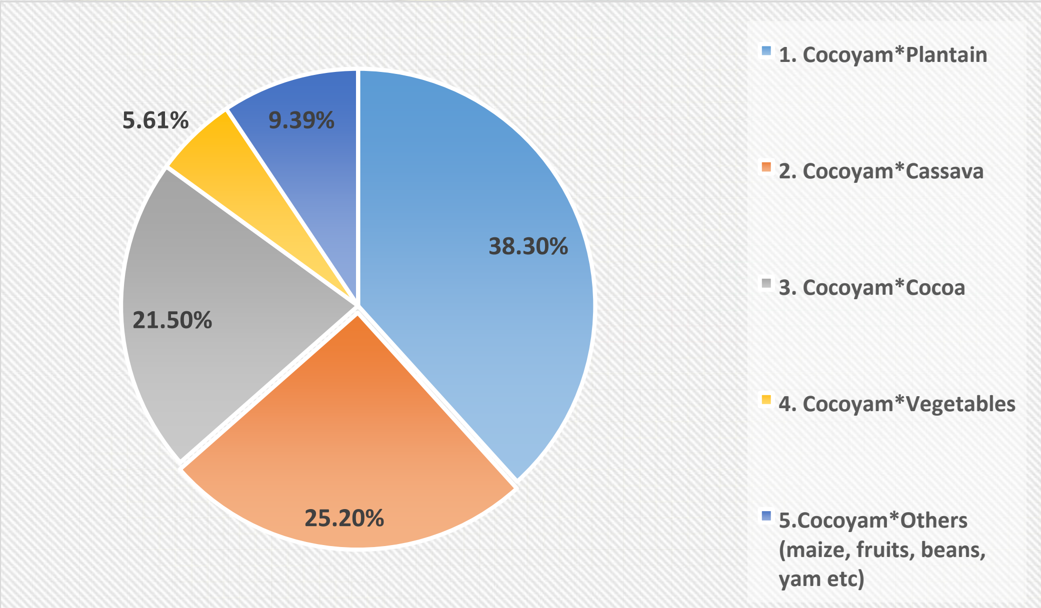
Source: Field Survey, 2015

#### 4.2.7.2 Commonest crops mostly intercropped with cocoyam

Figure 4.2 also shows the distribution of crops mostly intercropped with cocoyam. Cocoyam was predominantly intercropped with plantain, cassava and cocoa. Out of the 126 producers that cultivated cocoyam as intercrops, 38.3 percent indicated that plantain was the major intercrop whereas 25.2 percent and 21.5 percent of the producers mostly intercropped cocoyam with cassava and cocoa respectively. Only 5.6 percent of the producers intercropped cocoyam with vegetables (pepper, tomato and garden eggs). Other food crops like maize, yam, beans and fruits were also used as intercrops of cocoyam by some farmers but this constituted 9.36 percent of the producers interviewed. Cocoa as a major intercrop was more prevalent in Asante Akyem South (34 percent) and Asunafo North (20 percent) districts. However, in Fanteakwa, only 7.7 percent of such producers intercropped cocoyam.

However, plantain and cassava were the major crops intercropped with cocoyam in all districts. Figure 4.2 represents a pictorial form of the major intercrops of cocoyam in the pooled sample.

**Figure 4.2 Major crops intercropped with cocoyam in a mixed cropping system**




Source: Field Survey, 2015

#### 4.2.8.3 Main reason for cultivating cocoyam and main produce sold

Table 4.3 presents information on other production characteristics of cocoyam producers. The table shows that majority of cocoyam producers cultivated the root crop for food and commercial purpose. About 33 percent of the farmers cultivated cocoyam mainly for sale while 51 percent cultivated the root crop equally for household consumption and sale. About 9 percent cultivated cocoyam mainly for household consumption and sold the surplus. Only eight percent cultivated cocoyam purely on a subsistence basis. In the Fanteakwa district, 46 percent of the farmers cultivated cocoyam solely for sale and another 46 percent cultivated the crop equally for household consumption and sale suggesting that cocoyam was considered a major cash crop in this district. Six percent cultivated the root crop mainly for food but sold surplus while two percent cultivated cocoyam solely for household consumption.

**Table 4.3: Other production characteristics of cocoyam producers**

| **Variable** | **Asante Akyem South** | | **Asunafo North** | | **Fanteakwa** | | **Pooled** | |
|---|---|---|---|---|---|---|---|---|
| | **Freq** | **%** | **Freq** | **%** | **Freq** | **%** | **Freq** | **%** |
| **Main reason for growing cocoyam** N(AAS)=50; N(AN_D)=50; N(F_D)=50; N(Pooled)=150 | | | | | | | | |
| Household consumption only | 1 | 2 | 10 | 20 | 1 | 2 | 12 | 8 |
| Mainly for household consumption, sell surplus | 1 | 2 | 9 | 18 | 3 | 6 | 13 | 8.7 |
| Equally for sale and household consumption | 30 | 60 | 23 | 46 | 23 | 46 | 76 | 50.7 |
| Mainly for sale | 18 | 36 | 8 | 16 | 23 | 46 | 49 | 32.7 |
| **Target produce for sale** *N(AAS)=49; N(AS_N)=40; N(F_D)=49; N(Pooled)=138 | | | | | | | | |
| Corms only | 26 | 53.1 | 27 | 67.5 | 39 | 79.6 | 93 | 67.4 |
| Both leaves and corms | 23 | 46.9 | 13 | 32.5 | 10 | 20.4 | 45 | 32.6 |
| Leaves only | - | 0 | - | 0 | - | 0 | - | 0 |

*Total N for 'target produce for sale' does not include producers who cultivate for consumption only. Source: Field Survey, 2015

Majority of the farmers in Asunafo North district (46 percent) also cultivated cocoyam equally for household consumption as well as for sale whereas 16 percent planted the root crop solely for sale and 18 percent cultivated cocoyam both for household consumption and sale. However, about 20 percent of the cocoyam producers in Asunafo North district cultivated cocoyam purely for subsistence. Only two percent of the respondents in the Asante Akyem district cultivated cocoyam solely or mainly for household consumption. In the same district, 36 percent cultivated the root crop solely for sale while 60 percent cultivated cocoyam equally for household consumption and sales. Considering the fact that cocoyam is almost exclusively cultivated for household consumption and the surplus sold, this finding affirms the argument of Ajijola (2003) that cocoyam production constitutes a significant component of food production as well as income generation of producing households.

Cocoyam is a vegetable root crop with more than one part having economic value – mainly the corms and leaves. Table 4.3 also shows the main economic part that cocoyam farmers consider when producing for sale.

Out of the total 138 respondents who sold part or all of their harvested cocoyam, 67.4 percent indicated that the main target for cultivating cocoyam was the cormels or corms. In other words, majority of the farmers produced cocoyam specifically for the sale of corms.

About 32.6 percent of respondents on the other hand, cultivated cocoyam by targeting both the corms and the leaves (kontomire) for sale. None of respondents cultivated cocoyam solely for the sale of its leaves. This could be attributed to the fact that, producers recognized the corms as the most important economic part of the crop and considered cocoyam leaves only as a secondary economic part of the crop hence the reason why producers did not cultivate cocoyam solely for its leaves. Relatively higher percentage of cocoyam farmers (79.6 percent) from the Fanteakwa district target cormels or corms only for sale as compared to 67.5 percent and 53.1 percent of farmers from Asunafo North and Asante Akyem South districts respectively. Table 4.3 also shows that 46.9 percent of farmers in the Asante Akyem district target both the cocoyam leaves and cormels for sale, a case which is higher compared with 13 percent and 10 percent of such farmers in the Asunafo North and Fanteakwa districts. This results corroborates with the findings of Quaye *et al*. (2010) who found out that majority of cocoyam producers cultivate the root crop purposely for both corms and leaves.

### 4.3 Proportion of land under cocoyam cultivation

Table 4.4 shows the total agricultural land and cultivated land for cocoyam producers. It also shows the average sizes of cocoyam farms within the study districts.

### 4.3.1 Total cultivated land and cocoyam farm size

The total agricultural land controlled (either owned or otherwise) by cocoyam producers ranged from 0.53 hectares to 12.15 hectares. On the average, the total agricultural land controlled by cocoyam farmers was about 4.2 hectares with farmers in the Fanteakwa district controlling a mean agricultural total land of 4.79 hectares whereas producers from Asante Akyem South and Asunafo North districts controlled 3.23 hectares and 4.49 hectares on the average respectively.

Averagely, a typical cocoyam producer controlled a cultivated area of 2.98 hectares. Cocoyam producers in Fanteakwa cultivated more acreages compared to cocoyam farmers from Asante Akyem South and Asunafo North districts. The average total farmland cultivated by producers in Fanteakwa was about 3.37 hectares while cocoyam farmers in Asante Akyem and Asunafo North cultivated an average total land of 2.09 and 3.48 hectares respectively.

**Table 4.4: Total and cultivated land and area allotted for cocoyam by producers**

| Variable | | Minimum | Maximum | Mean | Std. Dev. | CV (%)[a] |
|---|---|---|---|---|---|---|
| Total agricultural land (hectares) | AAS | 0.61 | 8.10 | 3.23 4.49 | 1.68 | 52.01 |
| | AN_D | 0.53 | 8.91 | 4.79 | 3.20 | 66.81 |
| | F_D | 0.81 | 12.15 | | 2.59 | 54.07 |
| | Pooled | 0.53 | 12.15 | 4.17 | 2.62 | 62.83 |
| Total cultivated land (hectares) | AAS | 0.61 | 4.05 | 2.09 | 1.49 | 71.29 |
| | AN_D | 0.53 | 8.10 | 3.48 | 2.60 | 74.71 |
| | F_D | 0.81 | 10.12 | 3.37 | 2.91 | 86.35 |
| | Pooled | 0.53 | 10.12 | 2.98 | 2.17 | 72.82 |
| Cocoyam farm size (hectares) | AAS | 0.53 | 2.6 | 1.31 | 0.72 | 54.96 |
| | AN_D | 0.53 | 3.3 | 1.66 | 0.98 | 59.04 |
| | F_D | 0.61 | 3.8 | 1.97 | 1.08 | 54.82 |
| | Pooled | 0.53 | 3.8 | 1.54 | 0.85 | 55.19 |
| Actual farm size *(adjusted for farm area covered by cocoyam only)* | AAS | 0.25 | 0.59 | 0.38 0.77 | 0.14 | 36.84 |
| | AN_D | 0.36 | 1.1 1.5 | 0.84 | 0.29 | 37.66 |
| | F_D | 0.39 | 1.5 | 0.55 | 0.38 | 45.24 |
| | Pooled | 0.25 | | | 0.21 | 38.18 |

N (Pooled) =150; N(AAS) = 50; N(AN_D) = 50; N(F_D) = 50

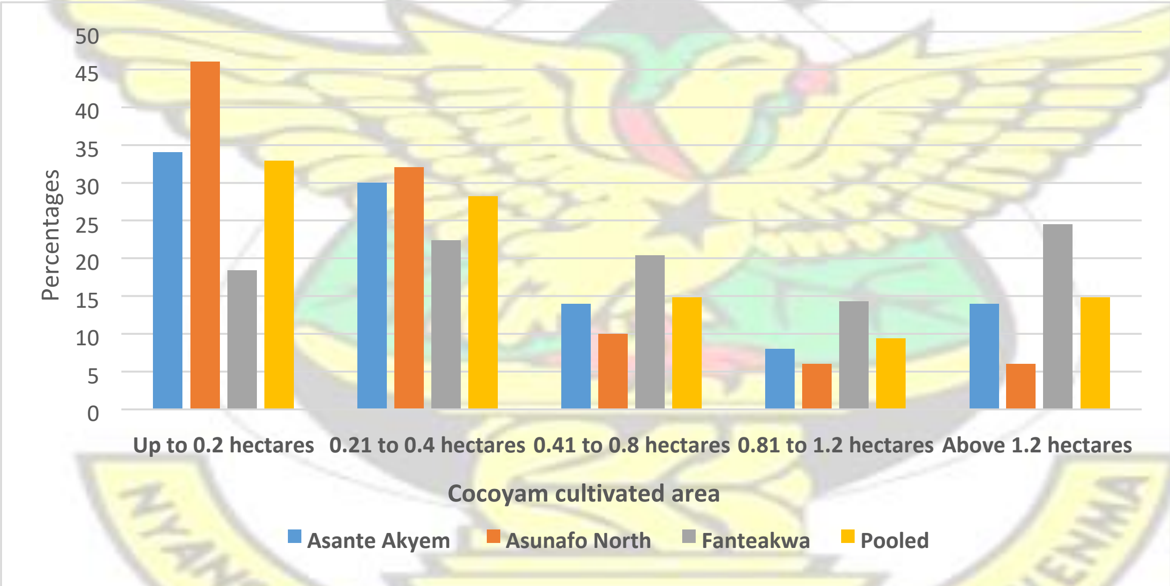
[a] Coefficient of variation (CV) is a measure of relative dispersion calculated by expressing standard deviation (SD) as a percentage of the mean (X) i.e. $CV = SD/\bar{X}$

Source: Author's Computation, 2015

Furthermore, Table 4.4 shows that the mean cocoyam farm size for cocoyam producers was 1.54 hectares. A typical cocoyam producer in the Asante Akyem South district had farm size of 1.31 hectares whereas the mean farm size for cocoyam producers in Asunafo North and Fanteakwa districts were 1.66 and 1.97 hectares respectively. This implies that cocoyam was cultivation was generally done on a small scale since the average cocoyam farm size was less than two hectares according to the definition of smallholder farming by Singh *et al*. (2002).

It is also worthy to indicate here that, size of cocoyam farm reflects the unadjusted farm size on which cocoyam was cultivated regardless of the cropping culture being practised on the farmland or the proportion of the farmland that cocoyam covers. Figure 4.3 shows the land under cocoyam cultivation for the three districts.

**Figure 4.3 Areas under cocoyam cultivation for the study districts**




Source: Field Survey, 2015



The actual area under cocoyam cultivation which was computed by adjusting for the mixed cropping system (i.e. by estimating the actual proportion or percentage of total cultivated land allocated for growing cocoyam) was an average of 0.55 hectares. The actual cocoyam farm size for producers in the Asante Akyem South district was an average of 0.38 hectares (0.94

acres). The average actual area under cultivation was 0.77 hectares (1.9 acres) and 0.84 hectares (2.07 acres) for Asunafo North and Fanteakwa districts respectively (Table 4.4). These results favourably compares with results of Quaye *et al*, (2010) who found that the average land area cultivated by cocoyam producers in Fanteakwa was 0.8 hectares however, Onyenweaku and Okoye (2007) in Nigeria found that the average cocoyam farm size was 0.27 hectares.

Estimates from an ANOVA analysis (F=7.68, $\rho$=0.001) indicate that the actual cocoyam farm sizes of producers in Asante Akyem South, Asunafo North and Fanteakwa districts significantly differed from each other. Table 4.5 presents the varying proportions of agricultural land and cultivated lands allotted for cocoyam production by producers in the study districts.

**Table 4.5 Proportion of cocoyam farm to total and cultivated land of producers**

| Variable | AAS | AN_D | F_D | Pooled |
|---|---|---|---|---|
| Proportion of planted cocoyam to volunteer cocoyam (%) | 73 | 64 | 77 | 71 |
| Proportion of cocoyam farm to total cultivated land (%) | 18.18 | 22.13 | 24.93 | 18.46 |
| Proportion of cocoyam farm to total agricultural land (%) | 13.60 | 16.92 | 17.94 | 13.11 |

N (Pooled) =150; N (Asante Akyem South) = 50; N (Asunafo North) = 50; N (Fanteakwa) = 50

Source: Field Survey, 2015

Cocoyam has a volunteer sprouting property – an action of plants to re-sprout voluntarily at later time even after the mother plant has been harvested (Onyeka, 2014). Volunteer cocoyam is considered a benefit by cocoyam farmers and are sometimes relocated or evenly shared on the farm. Table 4.5 shows that per 0.55 hectares of cocoyam farm, the proportion of cocoyam planted by farmers constituted an average of 71 percent whereas 29 percent of the cocoyam sprouted voluntarily. Farmers in the Asunafo North benefited more in terms of volunteer cocoyam compared to the other districts. In the Asante Akyem district, per an average of 0.38 hectares, 73 percent of the farm area was covered by planted cocoyam and 27 percent was covered by volunteer cocoyam. In Asunafo North district, 64 percent of 0.77 hectares were planted by farmers themselves whereas 36 percent were covered by volunteer cocoyam. About

77 percent of a typical cocoyam farm size of 0.84 hectares in the Fanteakwa district was covered by planted cocoyam.

Overall, approximately 13 percent of the total agricultural land (average of 4.2 hectares) controlled by cocoyam farmers was allotted to cultivating cocoyam alone. In Asunafo North district, 16.9 percent of the total agricultural land (average of 4.5 hectares) controlled by the cocoyam producers was committed to cocoyam alone while 17.9 percent and 13.6 percent of the total agricultural lands controlled by cocoyam producers in Fanteakwa and Asante Akyem South were committed to the cultivation of cocoyam alone.

### 4.3.2 Cocoyam farm size by cropping system practised

Table 4.6 presents information on proportions and other distributions of areas under cocoyam cultivation for the respondents, areas under cultivation for the various cropping systems. The average farm size for producers that cultivated cocoyam as pure stand was 0.93 hectares.

**Table 4.6: Mean hectares under cocoyam production relative to cropping systems**

| Variable | | AAS | AN_D | F_D | Pooled | T-value |
|---|---|---|---|---|---|---|
| Mono croppers | Mean | 0.59 | 0.91 | 1.36 | 0.93 | |
| | Std. Deviation | 0.21 | 0.35 | 0.58 | 0.38 | |
| | CV (%)[a] | 35.59 | 38.46 | 27.9 | 40.86 | 3.66*** |
| Mixed croppers | Mean | 0.76 | 1.12 | 1.21 | 1.04 | |
| | Std. Deviation | 0.46 | 0.56 | 0.58 | 0.55 | |
| | CV (%) | 60.53 | 50 | 47.93 | 52.88 | |

N (Pooled) =150; N (Asante Akyem South) = 50; N (Asunafo North) = 50; N (Fanteakwa) = 50 [a]

Coefficient of variation (CV) is a measure of relative dispersion calculated by expressing standard deviation (SD) as a percentage of the mean (X) i.e. $CV = SD/\bar{X}$.

*** denote 1% level of significance.

Source: Field Survey, 2015

Average areas under cocoyam cultivation for farmers who cultivated cocoyam as pure stand in the Asante Akyem South, Asunafo North and Fanteakwa were 0.59 hectares, 0.91 hectares and 1.36 hectares respectively. This goes to show that farmers from the Fanteakwa and Asunafo North districts committed more lands to cocoyam production than those in Asante Akyem

South. On the other hand, farm sizes under the mixed cropping system were relatively higher than the average farm size under the monocrop system. Average farm size for cocoyam farmers who intercropped cocoyam with other crops was 1.04 hectares. District wise, producers who intercropped cocoyam with other crops in Fanteakwa had the largest cocoyam farm size of 1.21 hectares, followed by those in Asunafo North district with 1.12 and Asante Akyem South with 0.76 hectares. As expected, Table 4.6 reveals that the mean size of (unadjusted) farm lands committed to cocoyam production by mixed croppers was significantly higher than the mean size of farms for cocoyam mono croppers i.e. t(148) =3.66, $\rho$= 0.000).

### 4.4 Yield analysis of cocoyam corms and leaves

Table 4.7 presents average yield of cocoyam (i.e. cormels and leaves) disaggregated into categories of districts and cropping systems under which cocoyam was cultivated. Detailed information on the average outputs and farm sizes are provided at appendix I.

**Table 4.7 Yield for corms and leaves harvested under different cropping system and districts.**

| | **Corm yield (kg/ha)** | | | **Leaves yield (kg/ha)** | | |
|---|---|---|---|---|---|---|
| | **AAS** | **AN_D** | **F_D** | **AAS** | **AN_D** | **F_D** |
| Mean | 6033.1 | 6624.8 | 6873 | 881.2 | 483.3 | 411.4 |
| Std. Dev. | 1032.9 | 1185.2 | 1241.3 | 217.4 | 152.2 | 137.3 |
| CV (%)[a] | 17.12 | 17.89 | 18.06 | 24.67 | 31.50 | 33.38 |
| | **Mono croppers** | **Mixed croppers** | | **Mono croppers** | **Mixed croppers** | |
| Mean | 7042 | 5984.7 | | 438.6 | 746.1 | |
| Std. Dev. | 1117.6 | 1218.5 | | 183.2 | 322.0 | |
| CV (%) | 15.87 | 20.36 | | 41.78 | 43.17 | |
| | **Overall mean yields** | | | | | |
| Mean | 6515.07 | | | 592.31 | | |
| Std. Dev. | 1213.1 | | | 253.4 | | |
| CV (%) | 18.62 | | | 32.79 | | |

*1 bag of corm = 80kg; 1 Bundle/roll of leaves = 0.35kg
N (Pooled) =150; N(AAS) = 50; N(AN_D) = 50; N(F_D) = 50

[a] Coefficient of variation (CV) is a measure of relative dispersion calculated by expressing standard deviation (SD) as a percentage of the mean (X) i.e. $CV = SD/\bar{X}$

Source: Field Survey, 2015.

On the average, the corm yield was approximately 6515kg per hectare (6.52mt/ha) whereas the average yield of cocoyam leaves was approximately 592kg per hectare (0.59mt/ha). The result on corm yield was consistent with national yield range between 6.3-6.8mt/ha according to FAOSTAT (2014) and MoFA-SRID (2010). The table further shows that 'pure stand' producers obtained higher average corm yield of 7042kg per hectare or 7mt/ha as compared to an average corm yield of 5984.7kg per hectare (5.98mt/ha) for producers intercropping cocoyam with other crops on the same piece of land.

The yield of cocoyam leaves however turned out to be the reverse considering the type of cocoyam producer. Mixed croppers harvested more leaves either for sale or for food than pure stand producers of cocoyam. Producers under the mixed cropping system harvested an average of 746.1kg per hectare (0.75mt/ha) and it was higher compared to the 438.6kg (0.44mt/ha) of leaves harvested by pure stand producers of cocoyam. The results of the t-tests conducted (Table 4.8) revealed that with t-statistic of 3.14 ($\rho$= 0.002), corm yield of the mono-cropping system was significantly higher than corm yield of the mixed cropping system.

**Table 4.8: T-test of equality of means**

| Yield | | N | Mean | Mean difference | t value | Sig (2-tailed) |
|---|---|---|---|---|---|---|
| Corms | Mono-cropping | 24 | 7042 | 10.44 | 3.142 | 0.002*** |
| | Mixed cropping | 126 | 5984.7 | | | |
| Leaves | Mono-cropping | 24 | 438.6 | 108.93 | 2.261 | 0.032** |
| | Mixed cropping | 126 | 746.1 | | | |

*** and ** denote 1% and 5% levels of significance respectively. Source: Author's Computation, 2015.

The null hypothesis which states that there is no difference between mean corm yields of mixed croppers and mono croppers is rejected at 1 percent level of significance in favour of the alternative hypothesis. The difference can be attributed to the purpose of cultivating cocoyam or intensification of production. It was observed that cocoyam sole croppers were more commercially inclined (produced for sale) than mixed croppers who mainly cultivated cocoyam for household consumption and often sold surplus. Mono-croppers were generally more productive because relatively, they were involved in more intensive cultivation per hectare for cocoyam production than mixed croppers.

Quantity of leaves harvested under the different systems can also accounts for the differences. Higher quantities of cocoyam leaves were harvested from mixed cropped farms than the mono cropped farms. With a t-statistic of 2.26 ($\rho$= 0.032), the null hypothesis that the mean yield of leaves is not statistically different under the two cropping systems is also rejected at 5 percent significance level. In other words, the quantity of cocoyam leaves harvested for sale or for household consumption under the mixed cropping system of production was significantly higher than the amount of cocoyam leaves harvested under the mono-cropping system of production. The leaf is the most important life-giving part of a plant. It primarily manufactures food through the process of photosynthesis (Coulter, 1994). Therefore, farmers who heavily harvest leaves are likely to lose when it comes to corm yield. Furthermore, the average yield for cocoyam producers in Asante Akyem South was 6033.1kg per hectare i.e. 6mt/ha which was comparatively lower to the average yield for producers in the Asunafo North district which was 6624.8kg per hectare (6.62mt/ha).

Cocoyam farmers in Fanteakwa had the highest corm yield of 6873kg per hectare, suggesting that cultivation in this district was the most productive followed by the Asunafo North and Asante Akyem South districts respectively. The amount of cocoyam leaves harvested in Fanteakwa represented the least yield compared to the other two districts and this is in tandem with observations made on the field.

### 4.5 Factors affecting cocoyam production in Ghana

Table 4.9 presents summary statistics of variables used in the production model. Some of the variables in the table have already been discussed under previous sub-sections. However, the average quantity of corm setts used for planting was about 457kg and this translates into 829.9kg of planting material per hectare. Farmers in Asunafo North planted an average of 836.8kg of corm setts (equivalent to 1086.8kg per hectare) which was comparatively higher than the mean for the pooled sample. Averagely, producers in Asante Akyem South, with an average of 232.8kg (equivalent to 612.6kg per hectare) of corm setts, relatively used the least quantity of corm setts for planting.

Cocoyam producers employed a mean of 70 man days (equivalent to 128 man-days per hectare) for the 2013/2014 cropping season. Averagely, cocoyam producers in Fanteakwa engaged about 109 man days (equivalent to 130 days per hectare) for production. This was relatively the highest amount of man days spent for production followed by a mean of 99.3 man days (129 days per hectare) for producers in Asunafo North and about 48 man days (equivalent to 125 man days per hectare) for farmers in Asante Akyem South.

It was observed on the field that a lot of the labour was employed in manual control of weeds till harvesting especially because producers consciously applied minimal or no herbicides at all. The results compares favourably with findings of Quaye *et al*. (2010) who found the total man days utilized per hectare of cocoyam production to be about 120 man days however, findings from studies in Nigeria such as Okoye *et al*. (2006) in Nigeria found that cocoyam producers use more labour and time for cocoyam production i.e. 142 man-days per hectare.

The average man days employed for cocoyam production was relatively higher when compared to man days required for production of other labour intensive root and tuber crops like cassava which is about 83 man days according to Ebukika (2010) and 86 man days for yam according Ibitoye and Onimisi (2013). This suggests that cocoyam is the root and tuber crop that requires most labour and time for its production.

| **Variable** | **Variable description** | **AAS** | **AN_D** | **F_D** | **Pooled** |
|---|---|---|---|---|---|
| Output | Quantity of corms harvested (kg) per ha | 6033.1 (1094.4)* | 6624.8 (2101.6) | (1984.8) | 6515.1 (1595.2) |
| Corm setts | Quantity of setts planted (kg) | 232.8 (63.41) | 836.8 (69.05) | 746.9 (74.15) | 456.5 (70.93) |
| Labour | Man days | 47.5 (12.06) | 99.3 (18.92) | 109.2 (18.83) | 70.44 (16.44) |
| Area harvested | Hectares | 0.38 (0.14) | 0.77 (0.29) | 0.84 (0.38) | 0.55 (0..21) |
| Other costs (fertilizer, fungicides) | GH¢ | 165.7 (64.24) | 122.11 (50.39) | 352.01 (95.53) | 203.81 (70.25) |
| Cropping system | = monocrop and = otherwise | 0.06 (0.24) | 0.20 (0.42) | 0.22 (0.4) | 0.16 (0.37) |
| Gender | = male and = otherwise | 0.42 (0.36) | 0.50 (0.24) | 0.76 (0.40) | 0.56 (0.49) |
| Leaves harvested | Quantity of leaves harvested (kg) | 334.9 (129.3) | 372.1 (103.9) | 345.6 (96.2) | 325.8 (194.2) |
| Extension contact | Number of visits per year | 3.54 (3.28) | 4.55 (3.29) | 5.36 (2.46) | 4.52 (2.88) |

| | | | | | |
|---|---|---|---|---|---|
| Age | Years | 44.86 (9.83) | 49.24 (13.59) | 50.24 (9.78) | 48 (11.5) |
| Herbicide usage | = herbicide use and = otherwise | 0.76 (0.41) | 0.24 (0.41) | 0.40 (0.41) | 0.47 (0.41) |
| Education | Years of formal education | 9.20 (2.57) | 8.07 (2.73) | 9.34 (2.76) | 8.92 (2.71) |
| Household size | Number of people in household | 6.04 (2.43) | 6.67 (3.52) | 7.73 (2.65) | 6.85 (3.01) |
| Land occupancy | 1= owned and 0= otherwise | 0.62 (0.39) | 0.58 (0.50) | 0.42 (0.50) | 0.54 (0.50) |
| Off-farm income | GH¢ | 1587.92 (1131.25) | 1006.2 (845.47) | 1011.2 (639.53) | 1201.77 (916.47) |
| Farming experience | Number of years in cocoyam farming | 9.57 (8.24) | 16.69 (13) | 19.76 (11.4) | 15.31 (11.84) |
| Cocoyam farm age | Number of years for continuous cultivation of cocoyam | 9.28 (7.19) | 10.2 (10.57) | 7.04 (11.61) | 8.21 (10.83) |
| Proportion of volunteer to planted cocoyam | Percentage | 27 (17.47) | 36 (26.91) | 23 (25.39) | 29 (24.17) |
| Location 1 | AAS; 1=yes and 0=otherwise | | | | .33 (47) |
| Location 2 | AN_D; 1=yes and 0=otherwise | | | | .33 (47) |
| N | | 50 | 50 | 50 | 150 |

**Table 4.9: Summary of descriptive statistics of production model**

*Figures in parentheses represents the standard deviation of the sample Source: Field Survey, 2015.

On the average, the cost incurred on other farm inputs was about GH¢ 204 which included about GH¢ 170 as cost of fertilizer and the rest as fungicide cost. Producers in Fanteakwa spent an average of GH¢ 352 on other inputs, which included about GH¢ 312 as cost of fertilizer and about GH¢ 34 as cost of fungicides.

This value was relatively higher than the cost incurred on fertilizer and fungicides by producers Asante Akyem South (about GH¢ 139 as cost of fertilizer and GH¢ 27 as fungicides cost totalling GH¢ 166) and Asunafo North farmers (about GH¢ 91 as cost of fertilizer and GH¢ 31 as fungicides costs totalling GH¢ 122).

The average number of extension visits received by cocoyam producers was approximately five times in a year. Farmers in the Fanteakwa district had an average extension contact of 5.4 times and this was the highest, followed by 4.6 times for producers in Asunafo North and 3.5 times for producers in Asante Akyem South district. The average off-farm income received by cocoyam producers was GH¢ 1201.77. Off-farm income received was however highest in Asante Akyem South with GH¢ 1587.92, followed by an average amount of GH¢ 1011.2 for Fanteakwa and GH¢ 1006.2 for farmers in Asunafo North.

Table 4.9 also shows the average number of years that cocoyam producers had continuously farmed on their current cocoyam farmland. The table reveals that averagely, a piece of cocoyam farm had been cultivated for about eight years continuously. The average number of years of continuous cultivation of cocoyam on the same piece of land was approximately nine years, 10 years and seven years for Asante Akyem South, Asunafo North and Fanteakwa districts respectively. This phenomenon of continuous cropping (without fallow periods) has serious implications for the fertility status of soils and yield. It was found out that cocoyam producers scarcely applied fertilizer or any other forms of nutrient enhancing substances to their soils partly due to financial constraints and a perception that fertilizers reduce the storability and taste of the corms. Yields on farms that have been cultivated continuously for more than five years are expected to be far lower than farmlands that are left to fallow periodically.

Table 4.10 shows results of the hypotheses tested. Initially, both the Cobb Douglas and Translog Stochastic Frontier models were estimated to ascertain which of the two forms would best fit the data. The likelihood ratio test was therefore conducted to ascertain the best fit model for the data. As shown in table 4.7, the LR test statistic of 10.86 was lower than the critical value of 23.21 hence the null hypothesis was not rejected.

**Table 4.10: Outcome of hypotheses and multicollinearity tests**

| Null hypotheses | Statistic | *p* value | Decision |
|---|---|---|---|
| **1.** $H_0 : \square_{ij}\ \square\ 0$<br>$H_1 : \square_{ij}\ \square\ 0$<br>**$H_0$:** The Cobb-Douglas stochastic production function (restricted model) is as suitable for the data as the Translog stochastic model (less restricted model). | LR test<br>10.86*** | 0.001 | Accept $H_0$ |

| | | | |
|---|---|---|---|
| **2.** $H_0 : \square\ \square_1 \square\ \square\ \square_2 ... \square_{20} \square\ 0$ | Wald $\chi^2$ | 0.000 | Reject $H_0$ |
| $H_1 : \square\ \square_1 \square\ \square\ \square_2 ... \square_{20} \square\ 0$ | 533.24*** | | |
| **$H_0$:** Explanatory variables have no joint effect on the corm output | | | |
| **Multicollinearity test results*** | | | |
| | **Collinearity statistics** | | |
| **Variable** | **Tolerance** | **VIF** | |
| lncormoutput (dependent variable) | | | |
| Lncorms | 0.543 | 1.843 | |
| Lnfrmsz | 0.499 | 2.006 | |
| lnlabour | 0.510 | 1.960 | |
| lnothercosts | 0.736 | 1.359 | |
| lnleaves_harv | 0.322 | 3.101 | |

***Test results showed presented are for selected variables. Full test results can be found at appendix II. *** denotes 1% level of significance. Source: Author's Computation, 2015

Table 4.10 also presents estimates of parameters of both models (Cobb-Douglas and Translog) that were run together with their respective diagnostic statistics however, going forward, all discussions were based on only the Cobb-Douglas estimates since the LR test conducted affirms that it is as good to fit the data as the translog model. Subsequently, it was hypothesised that explanatory variables fitted into the Cobb Douglas production model had no significant joint influence on output. The Wald $\chi^2$ statistic of 533.24 was significant at 1 percent. The null hypothesis was therefore rejected in favour of the alternative hypothesis. This implies that the explanatory variables jointly influenced cocoyam output significantly. Further diagnostics was conducted to test the presence of possible multicollinearity amongst explanatory variables. There was an absence of multicollinearity in the model after the initial analysis (Table 10). All the Variance Inflation Factor (VIF) of the loaded explanatory variables were found to be less than the condition index benchmark of VIF $\geq$ 5 (see appendix II for detailed results). According to Bersley *et al*. (1980) the presence of multicollinearity is established if any of the explanatory variables in a model has a VIF $\geq$ 5.

Therefore, it was safely concluded that statistically, there exists no significant collinearity among explanatory variables in the model. Table 4.11 shows the results of the cocoyam production function model that was estimated.

**Table 4.11: Maximum likelihood estimates of cocoyam production function (pooled).**

| Variables | Cobb Douglas SFM | | Translog SFM | |
|---|---|---|---|---|
| | Coefficient | Std. Error | Coefficient | Std. Error |
| Constant | 5.47*** | 0.43 | 6.18** | 3.11 |
| lncormsetts | 0.101*** | 0.031 | 0.114* | 0.059 |
| lnmandays | 0.208** | 0.096 | 0.089 | 1.153 |
| lnareaharve | 0.174*** | 0.049 | 2.34*** | 0.875 |
| lnothercosts | 0.0008*** | 0.0002 | -0.023** | 0.01 |
| $lncormsetts^2$ | | | -0.128** | 0.057 |
| $lnmandays^2$ | | | -0.132 | 0.244 |
| $lnareaharve^2$ | | | -0.289** | 0.138 |
| $lnothercosts^2$ | | | -0.099 | 0.134 |
| lncormsetts*lnmandays | | | 0.023* | 0.012 |
| lncormsetts*lnareaharve | | | 0.114*** | 0.06 |
| lncormsetts*lnothercosts | | | -0.023 | 0.642 |
| lnmandays*lnareaharve | | | 0.314* | 0.174 |
| lnmandays*lnothercosts | | | 0.14 | 0.137 |
| lnareaharve*lnothercosts | | | 0.116** | 0.049 |
| crop_system | 0.138** | 0.061 | 0.122* | 0.071 |
| gender | 0.142** | 0.058 | 0.138** | 0.057 |
| lnqty_leaves_harv | -0.002*** | 0.0005 | -0.001*** | 0.0005 |
| lnext_contact | 0.019* | 0.01 | 0.015 | 0.01 |
| lnage | 0.002 | 0.003 | 0.003 | 0.003 |
| chemusage | -0.109* | 0.065 | -0.149** | 0.063 |
| lneduc | 0.033** | 0.014 | -0.028 | 0.023 |
| lnhhsize | 0.02* | 0.011 | 0.014 | 0.01 |
| land_occup | 0.068 | 0.056 | 0.025 | 0.058 |
| lnofffarminc | 0.0001 | 0.0006 | 0.0004 | 0.0006 |
| lnfarmexp | 0.014*** | 0.004 | 0.014*** | 0.004 |
| lnfarmage | -0.012* | 0.005 | -0.011*** | 0.004 |
| lnvolunteer_proportion | 0.002 | 0.001 | -0.002 | 0.001 |
| location1 | -0.125* | 0.072 | -0.046 | 0.811 |
| location2 | -0.011 | 0.761 | 0.04 | 0.843 |
| Observations | 150 | | | |
| $Sigma^2$ | 0.078*** | 0.009 | 0.081*** | 0.008 |
| Lambda | 0.618*** | 0.085 | 0.672*** | 0.089 |
| Log likelihood statistic | -21.49 | | -16.06 | |

***;**; * denote 1%, 5% and 10% levels of significance.

Source: Author's Computation, 2015.

From Table 4.11, the estimated sigma-squared value (the estimate of the total error variance) of 0.078 and 0.618 for lambda (the estimate of the ratio of the standard deviation of the inefficiency component to the standard deviation of the idiosyncratic component) were both significant at 1 percent indicating the correctness of the distribution form assumed for the composite error term. This therefore, justifies the appropriateness of the stochastic frontier and maximum likelihood approach in the analysis of the data.

All factors of production were found to have significant and positive influence on corm yield. The quantity of planting materials used had a positive effect on corm output and was significant at 1 percent level. With an elasticity of 0.101, this implies that a percentage increase in quantity of corm setts used will result in a 0.101 percent increase in corm output indicating a less than proportionate increase in corm output. Similarly, labour had a positive effect on corm output and was significant at 5 percent level. A percent increase in labour will result in a 0.208 percent in cocoyam output *ceteris paribus*.

The area harvested for cocoyam also highly significant at 1 percent and positively related to corm output with an elasticity of 0.174. This implies that a percentage increase in the area harvested of cocoyam farm size will result in 0.174 percent increase in the overall corm output holding all other factors constant. The cost of other inputs used like fertilizer and fungicides, significantly and positively affected corm output. The result implies that a percentage increase in the amount of money spent on fertilizer and fungicides will result in 0.0008 percent increase in output. The sum of elasticities of production factors was 0.484 implying a decreasing returns to scale in cocoyam production. All else being equal, a one percent increase in all variable inputs will result in less than one percent (0.484 percent) increase in cocoyam output.

Generally, these results confirm estimates from Azeez and Madukwe (2010) that quantity of cocoyam setts and labour have a positive effect on corm output. However in that study, area cultivated had no significant effect on output of corms. On the other, Onyenweaku and Okoye (2007) found that cocoyam farm size, quantity of planting material (corm setts), labour and other inputs significantly influenced corm output positively.

Other variables of policy relevance were also found to have significant influence on cocoyam production. The type of cropping system adopted by cocoyam producer had a positive and significant influence on corm output at 5 percent level of significance.
All else equal, cultivating cocoyam under the mono-cropping system increased output by at least 13.8 percent compared to cultivating the root crop as an intercrop. This could be because, growing cocoyam in pure stand eliminates competition of scarce soil nutrients and water with

other crops like cassava, plantain and cocoa – which are mostly intercropped with cocoyam and are heavy feeders – hence yield is boosted in the short and long run *ceteris paribus*.

Again, cultivating cocoyam under the mono-cropping system ensures a more dedicated and productive application of factors of production (land, labour, corm setts and other inputs) and attention which is often not the case in the mixed cropping scenario where resources are disproportionately distributed and often bias towards the main crop. The result is corroborated by Sagoe, *et al.* (2006) who found that the type of cropping system under cocoyam is produced has a significant effect on the yield of cocoyam. However, in Azeez and Madukwe (2010), cropping pattern was not found to have any significant effect on corm output.

Harvesting of cocoyam leaves for either for sale or for household consumption negatively influenced corm output and it was highly significant at 1 percent. In Ghana, cocoyam leaves are mostly used as vegetable for the preparation of sauces, stews and soups. The demand for the fresh and young leaves also known as 'kontomire' is therefore ubiquitous. However, the results show that holding all other predictors constant, a percent increase in the quantity of 'kontomire' harvested, resulted in 0.002 percent decrease in output of cocoyam corm. Similar results were obtained by Asumadu *et al*. (2011) and Safo-Kantanka (1988) when they employed the experimental approach. The negative effect of harvesting of cocoyam leaves on corm yield can be largely due to the fact that leaves, physiologically, are responsible for the manufacture of food by plants. Therefore, harvesting of leaves for sale or household consumption or for any other use hinders the process of photosynthesis which in turn affects corm yield (Coulter, 1994).

Male gender was also found to significantly influence corm output positively. According to Table 4.11, at 5 percent significance level, male cocoyam producer obtained 14.2 percent higher output than female cocoyam producer, *ceteris paribus*. This can be attributed to the fact that cultivating cocoyam is a very labour-intensive agricultural enterprise and given the fact that females have less physical capacity or strength and also have less access to capital to employ labour and production factors, they are left with no choice than to work on their farms with below-optimum labour needs and this apparently reduces expected yield.
Again, the positive effect of male gender on cocoyam output could be because males have more access to fertile and virgin lands than females hence, being more productive. FAO (2002)

indicates that in customary societies such as in Ghana, women, unlike men, have very limited direct access to land and that their right to land use is usually acquired through their status as wives, mothers, sisters or daughters. The results corroborates the findings of Azeez and Madukwe (2010) that male gender positively influence cocoyam production.

The number of extension contacts was also significant at 10 percent level of significance and positively affected output of cocoyam. It was found out that a percent increase in the number of extension visits or trainings resulted in an increase in cocoyam production by 0.019 percent. Cocoyam producers who have frequent interactions with extension agents are privy to current agricultural technologies and technical advice. Increased extension contact and training leads to more knowledge dissemination of new and improved cocoyam technologies thereby enhancing production.

On the other hand, the application of herbicides was found to negatively affect production. The results show that at 10 percent significance level, cocoyam producers who applied herbicides to control weeds had reduced overall corm output by 10.9 percent compared to those who did manual weed control. This outcome resonates with the perception of cocoyam farmers that herbicides usage kills off sprouting setts and creates hostile environment for dormant volunteer corms from sprouting. Such situation can probably be attributed to the bad timing of chemical application, poor methods of application and the lack of use of recommended herbicides. Because cocoyam is predominantly planted as an intercrop, farmers may not be particular about the appropriate timings, methods and type of herbicides applied to farms containing cocoyam thereby reducing the plant count per piece of land.

Education also had a positive and significant effect on the corm output at 5 percent level of significance. This implies that a percent increase in the number of years of formal education of producers resulted in an increase in output by 0.033 percent. Increasingly, agricultural innovation and technologies are being handed down to farmers through extension agents and other technology dissemination media and as Battese and Coelli (1995) argue, education tends to enhance the farmers ability to appreciate and utilize existing and new technologies.

Furthermore, household size was found to have a significant positive effect on corm production at 10 percent significance level. According to the results in Table 4.11, a percent increase in the size of household increases corm output by a 0.02 percent margin. Larger farming households have higher and ready access to relatively cheaper labour – a case of satisfactory alternative for small holder resource-poor farmers with highly constrained choices.

Number of years of farming cocoyam (farming experience) also had a positive and highly significant influence on corm output. This implies that a percent increase in the number of years of cultivating cocoyam increase corm production by 0.014 percent. As producers continue to cultivate cocoyam, a lot of experience is acquired both through observation and development of innovative skills to improve output. These results agree with those of Onyenweaku and Okoye (2007) that socio-economic variables like household size, farming experience and number of extension contacts have positive and significant effects on cocoyam productivity.

Table 4.11 also shows that the number of years of continuous cultivation of cocoyam on the same piece of land impacted corm output negatively at 5 percent level of significance. A percent increase in the years of continuous cultivation on the same piece of farmland resulted in 0.012 percent decrease in overall output holding all other factors constant. It is worth indicating that, cocoyam farms are scarcely fertilized. A common perception among producers is that, fertilizer reduces the storability of the corms. Therefore, continuous cropping on the same piece of land for years with little or no form of nutrient replenishment strategy like fallowing will result in reduced yields over time. This resonates with the findings of Talwana *et al*, (2009) who revealed that 80 percent of cocoyam producers interviewed continuously cultivated cocoyam on one piece of land which was not usually fallowed as a result of land shortage. Diao and Sarpong (2007) also observed and predicted that, if soil nutrient losses are not consciously checked, cocoyam yield would diminish by 45 percent by 2015.

Finally, location of the farmer was found to significantly influence cocoyam production in Ghana. All things being equal, a cocoyam producer in Fanteakwa district had higher output than a producer in Asante Akyem South. It was observed that cocoyam producers in the Fanteakwa were more commercially oriented, cultivated larger acreages of cocoyam and more of them cultivated the root crop as a monocrop comparative to producers at Asante Akyem South district hence the likelihood of them being more productive.

### 4.5.1 District level estimates of the Cobb-Douglas stochastic production model district

Table 4.12 presents the results of estimates of production parameters specific to the three districts under study. Estimated factors of production like quantity of corm setts used, labour, and area harvested had significant positive effect on corm production in the Asante Akyem South, Asunafo North and Fanteakwa districts.

**Table 4.12: Estimates of the determinants of cocoyam production in specific districts**

| Variables | Asante Akyem South | | Asunafo North | | Fanteakwa | |
|---|---|---|---|---|---|---|
| | Coefficient | Std. Error | Coefficient | Std. Error | Coefficient | Std. Error |
| Constant | 4.852*** | 0.833 | 6.303*** | 1.029 | 6.235*** | 1.152 |
| lncormsetts | 0.455*** | 0.089 | 0.568*** | 0.09 | 0.425** | 0.188 |
| lnmandays | 0.515*** | 0.192 | 0.359** | 0.123 | 0.232** | 0.110 |
| lnareaharve | 0.149** | 0.072 | 0.145** | 0.059 | 0.107** | 0.056 |
| lnothercosts | -0.203** | 0.096 | 0.014 | 0.152 | 0.078 | 0.146 |
| crop_system | 0.109 | 0.294 | 0.142*** | 0.038 | 0.178*** | 0.067 |
| gender | -0.097 | 0.071 | 0.221* | 0.125 | 0.219* | 0.114 |
| lnleaves_harv | -0.002*** | 6.3e-4 | -0.002*** | 7.5e-4 | -0.002 | 0.003 |
| ext_contact | 0.038*** | 0.014 | 0.075** | 0.032 | 0.023*** | 0.08 |
| lnage | 0.003 | 0.002 | 0.017 | 0.016 | 0.015** | 0.006 |
| chemusage | -0.136* | 0.072 | -0.201** | 0.100 | -0.241** | 0.105 |
| lneduc | 0.005 | 0.004 | 0.039 | 0.186 | 0.051** | 0.019 |
| lnhhsize | 0.005 | 0.015 | 0.051*** | 0.016 | 0.056*** | 0.015 |
| land_occup | 0.005 | 0.061 | 0.130 | 0.104 | 0.124 | 0.099 |
| lnofffarminc | 0.0001 | 7.5e-4 | 0.0002*** | 9.9e-5 | 0.0023** | 9.3e-4 |
| lnarmexp | 0.031** | 0.017 | 0.023*** | 0.007 | 0.022*** | 0.007 |
| lnfarmage | -0.005 | 0.061 | -0.018** | 0.006 | -0.020*** | 0.006 |
| lnvolunteer_ proportion | -0.0004 | 0.001 | -0.0008 | 0.002 | -0.002 | 0.002 |
| Observations | 50 | | 50 | | 50 | |
| $Sigma^2$ | 0.070*** | 0.004 | 0.072*** | 0.008 | 0.078*** | 0.005 |
| Lambda | 0.64*** | 0.19 | 0.69*** | 0.05 | 0.70*** | 0.11 |
| Log likelihood statistic | -25.8 | | -20.5 | | -28.3 | |

***, **,* denote 1%, 5% and 10% levels of significance.

Source: Author's Computation, 2015.

At 5 percent level of significance, the amount invested in other inputs only had a negative significant effect on corm production in Asante Akyem South with an input elasticity of 0.5 percent.

This indicates that a percent increase in the amount spent on other inputs results in a 0.5 percent reduction in corm output for producers within the Asante Akyem South district. However, according to the elasticities of factor inputs for the three districts, cocoyam production in Asante Akyem South and Asunafo North exhibited increasing returns to scale with total inputs elasticities of 1.086 and 1.322 respectively whiles cocoyam production in Fanteakwa ($\mathcal{E}_p$ = 0.842) exhibited a decreasing returns to scale. In effect, whilst Fanteakwa cocoyam producers are in stage two of production, producers in Asante Akyem South and Asunafo North are operating at the first stage of production which means that increase in the levels of usage of all factor inputs will result in a more than proportionate increase in cocoyam output in these districts.

The type of cropping system adopted for cocoyam cultivation was only significant and positively affected corm production in Asunafo North and Fanteakwa districts at the 1 percent levels. Cultivating cocoyam in pure stand increased corm output by 14.2 percent and 17.8 percent for Asunafo North and Fanteakwa districts respectively. Similarly, male gender had a positive and significant influence on corm output in Asunafo North and Fanteakwa at 10 percent level. Male producers obtained higher corm output of 22.1 percent and 21.9 percent respectively.

Table 4.12 further shows that the amount of 'kontomire' harvested significantly and negatively affected corm output both in Asante Akyem and Asunafo North. A percent increase in the quantity of cocoyam leaves harvested reduced corm output of producers of the respective districts by 0.002 percent. This variable was not significant in the Fanteakwa district probably due to the relatively limited quantity harvested as well as the time of harvesting of leaves. It was observed that the fresh leaves were harvested only from cocoyam plants (corms) ready to be harvested or cocoyam plants which were more than nine months on the field. By this approach, corm development was not significantly hampered.

Extension contact and interaction also had a positive and significant influence on corm production at 1 percent significance level for producers in Asante Akyem South and Fanteakwa districts and 5 percent significance level for producers in the Asunafo North district. Output increased by 0.038 percent, 0.075 percent and 0.023 percent for a percent increase in number of extension contacts per year *ceteris paribus*.

According to Table 4.12, the use of weed killers negatively affected corm production significantly at 10 percent, and 5 percent significant levels for Asante Akyem South, Asunafo North and Fanteakwa respectively. Corm production reduced by 13.6 percent, 20.1 percent and 24.1 percent as a result of applying herbicides in Asante Akyem South, Asunafo North and Fanteakwa districts of Ghana respectively. The number of years of formal education positively influenced corm output in Fanteakwa and was significant 5 percent. All things being equal, a percent increase in the number of years of formal education increases corm output by 0.51 percent. Table 4.12 further shows that age significantly and positively influence corm production at 5 percent significance level in Fanteakwa.

Furthermore, the effect of household size corm output was positive and significant in Asunafo North and Fanteakwa districts at 1 percent significance level. A percent increase in household size increased corm output by 0.5 percent and 1.6 percent *ceteris paribus* for Asunafo North and Fanteakwa districts respectively. This can be attributed to the fact that unlike in Asante Akyem South, access to hired labour at affordable rates was problematic hence a heavier dependency on household labour for production. Off farm income only had a significant positive effect on corm output in Asunafo North and Fanteakwa districts at significance level of 1 percent and 5 percent respectively. In other words, the amount of money received from off-farm economic activities by cocoyam producers in Asunafo North and Fanteakwa, were in turn invested into cocoyam production to increase corm output.

Table 4.12 also shows that the number years of cocoyam farming had a significant positive influence on corm production across the three districts. On the other hand, the effect of number of years of continuous cropping of the same piece of cocoyam farmland on output was negatively significant for Asunafo North and Fanteakwa districts 1 percent and 5 percent significant level. A percent increase in number of years of continuous cropping of farmland decreased corm output for by 0.018 percent and 0.02 percent for producers in Asunafo North and Fanteakwa respectively. The difference could probably due to the fact that in Asante Akyem South where cocoyam is predominantly intercropped with other crops especially cocoa, farmlands often receive some form of nutrient replenishment through fertilizer application therefore continuous cropping does not necessarily translate into poor yields. Cocoyam farmlands in the other districts are often intercropped with other root crops and plantain which are mostly not fertilized.

### 4.6 Financial profitability analysis of cocoyam production

Table 4.13 shows a summary of per hectare analysis of costs incurred by cocoyam farmers. The information has been disaggregated into district level in order to highlight subtle differences in the costs of production among districts.

**Table 4.13: Cost analysis on cocoyam production (hectare) in producing districts**

| Cost Item | Average Value (GH¢) | | | | % share of total variable cost (of pooled) | % share of total cost pooled)(of |
|---|---|---|---|---|---|---|
| | Asante Akyem | Asunafo North | Fanteakwa | Pooled | | |
| **Variable cost** | | | | | | |
| Labour cost | | | | | | |
| Vegetation clearing & land preparation | 330 | 330 | 330 | 330 | | |
| Carting of corms | 84 | 70 | 50 | 66 | | |
| Planting & sett preparation | 330 | 360 | 300 | 330 | | |
| Weeding (3 times) | 450 | 495 | 525 | 495 | | |
| Spraying | 60 | 45 | 60 | 60 | | |
| Fertilization | 36 | 30 | 36 | 33 | | |
| Harvesting | 405 | 375 | 435 | 405 | | |
| Gathering/heaping | 120 | 120 | 76 | 99 | | |
| Total labour cost | 1815 | 1825 | 1812 | 1818 | 60 | 54 |
| Corm setts | 210 | 300 | 250 | 243 | 8 | 7 |
| Herbicide | 107 | 142 | 101 | 108 | 9 | 8 |
| Fertilizer | 214 | 355 | 189 | 261 | 3 | 3 |
| Marketing costs | | | | | | |
| Loading & Offloading | 51 | 64 | 61 | 57 | | |
| Market tolls/tickets | 49 | 50 | 60 | 52 | | |
| Carriage/transportation | 306 | 274 | 826 | 488 | | |
| Total marketing cost | 406 | 388 | 947 | 597 | 20 | 18 |

| | | | | | |
|---|---|---|---|---|---|
| **Total variable cost** [A] | **2752** | **3010** | **3299** | **3027** | |
| **Fixed costs** Land rent | 207 | 104 | 225 | 180 | 5 |
| Farm assets (cutlass, sacks, baskets) | 135 | 118 | 135 | 127 | 4 |
| Depreciation (hoes, sprayers) | 26 | 31 | 39 | 33 | 1 |
| **Total fixed cost** [B] | **368** | **253** | **399** | **340** | |
| **Total cost (A+B)** | **3120** | **3263** | **3698** | **3367** | |

GH¢ 1.00 = USD 0.29

Source: Field Survey, 2015

Detailed information including the quantities and prices used for estimation can be found at appendix III. From the pooled sample, cocoyam producers spent GH¢ 3027 per hectare on variable inputs which includes labour, planting materials, agrochemicals, cost of transportation, loading and offloading charges and market taxes. However, the average total variable cost incurred by producers in Asante Akyem South, Asunafo North and Fanteakwa districts were GH¢ 2752, GH¢ 3010 and GH¢ 3299 respectively. The average fixed cost incurred per hectare was GH¢ 340 whereas the total cost of production per hectare averaged about GH¢ 3367. Total labour cost per hectare formed about 60 percent and 54 percent of the total variable cost and total production cost respectively making it the single most important cost component of cocoyam production (Table 4.13).

This result confirms the fact that cocoyam enterprise is indeed a labour-intensive one, as stated by Onyeka, (2014). It also compares favourably with the findings of Quaye *et al* (2010) and Okoye (2006) that the cost of labour alone constitutes more than half of the total variable cost incurred in a cocoyam production enterprise. In Asunafo North, producers spent an average of GH¢ 1825 per hectare on labour. This was the highest amongst cocoyam producers compared to GH¢ 1815 for Asante Akyem South and GH¢ 1812 for Fanteakwa producers. Weeding was the most labour intensive activity for cocoyam production followed by harvesting. A total of GH¢ 210, GH¢ 300 and GH¢ 250 were spent by producers in Asante Akyem South, Asunafo North and Fanteakwa districts respectively on planting material (corm setts).

The cost of planting material formed seven percent of the total cost of production. Farmers in Asunafo North spent highest on agrochemicals (weedicides and chemical fertilizers) incurring an average of GH¢ 497 per hectare compared to GH¢ 321 and GH¢ 290 for producers in Asante

Akyem South and Fanteakwa districts respectively. The cost of marketing, which includes loading and offloading charges, market tickets and transportation charges, was highest in Fanteakwa district with an average of GH¢ 947. In Fanteakwa, farmers incurred relatively more cost in marketing because they mostly preferred to sell produces at the major market centres. These major market centres (Ashaiman, Agbogbloshie and Kasoa) are in the country's capital – Accra which is about 125km away from the district capital, Begoro. Producers in Asante Akyem South and Asunafo North on the other hand, incurred an average of GH¢ 406 and GH¢ 388.8 per hectare respectively as marketing cost. The cost of marketing, an average of GH¢ 597, represented about 18 percent of the total cost of production per hectare.

Cocoyam farmers incurred a mean fixed cost of GH¢ 340 per hectare. An average fixed cost of GH¢ 368, GH¢ 253 and GH¢ 399 were specifically incurred by producers in Asante Akyem South, Asunafo North and Fanteakwa districts respectively. A typical cocoyam producer spent about GH¢ 3367 for producing cocoyam per hectare. Consequently, the overall cost of production per hectare for cocoyam producers in Fanteakwa was GH¢ 3698 per hectare whereas producers in Asunafo North and Asante Akyem South districts incurred GH¢ 3263 and GH¢ 3120 as production cost per hectare of cocoyam respectively. Table 4.14 shows the returns and profitability analysis for cocoyam production.

**Table 4.14: Costs and returns (profitability) analysis of cocoyam production (hectare) by districts**

| Item | Average Value (GH¢) | | | |
|---|---|---|---|---|
| | **Asante Akyem South** | **Asunafo North** | **Fanteakwa** | **Pooled** |
| Summary of costs | | | | |
| Total variable cost [A] | 2752 | 3010 | 3299 | 3027 |
| Total fixed cost [B] | 368 | 253 | 399 | 340 |
| Total cost [C] (A+B) | 3120 | 3263 | 3698 | 3367 |
| **Cocoyam output** | | | | |
| Quantity of corms harvested (kg) | 6033 | 6623 | 6873 | 6515 |
| Selling price per kg (corms) | 1.01 | 1.09 | 1.29 | 1.13 |
| Quantity of leaves harvested (kg) | 881 | 483 | 411 | 592 |
| Selling price per kg (leaves) | 1.4 | 1.4 | 1.4 | 1.4 |
| **Revenue (value of production)** | | | | |
| Corms **[D]** | 6093 | 7219 | 8866 | 7362 |
| Leaves | 1233 | 676 | 575 | 829 |
| Total returns **[E]** | 7327 | 7895 | 9442 | 8191 |

| | | | | |
|---|---|---|---|---|
| % contribution of leaves to total revenue | 17 | 9 | 6 | 11 |
| **Gross Margin (D-A) (corm only)** [F] | **3341** | **4209** | **5567** | **4335** |
| **Gross Margin (E-A)** [G] | **4575** | **4885** | **6143** | **5164** |
| **Net Income (D-C) (corm only)** | **2973** | **3956** | **5168** | **3995** |
| **Net Income (E-C)** | **4207** | **4632** | **5744** | **4824** |

GH¢ 1.00 = USD 0.29
Source: Field Survey, 2015

Averagely, the total revenue accrued from both corms and leaves harvested for the production season was GH¢ 8191 per hectare. However, total or gross revenue per hectare of cocoyam production was highest in Fanteakwa with an average of GH¢ 9442 whereas producers in Asante Akyem South and Asunafo North recorded an average of GH¢ 7327 and GH¢ 7895 as total gross proceeds. Proceeds from the sale of cocoyam leaves constituted about 11 percent of the total revenue received by farmers with farmers in Asante Akyem South obtaining the highest contribution (17 percent) of leaves to cocoyam revenue suggesting that revenue from the sale of cocoyam contributes significantly to the profitability and overall income from cocoyam. Cocoyam farmers obtained a gross margin of GH¢ 5164 per hectare production season.

Specifically, farmers in Asante Akyem South earned GH¢ 4575 per hectare as gross margin whereas producers from Asunafo North and Fanteakwa districts respectively earned GH¢ 4885 and GH¢ 6143 as gross margin per hectare. Farmers in the Fanteakwa obtained highest gross revenue and gross margin basically because of the relatively good produce price of GH¢ 1.1 per kilogram compared to GH¢ 0.9 and GH¢ 0.8 per kilogram of corm sold at Asante Akyem South and Asunafo North respectively. Sagoe *et al*. (2006) found out that the gross farm gate benefits of cocoyam was GH¢ 2090 per hectare for corms proceeds only. This could indicate that revenue from cocoyam enterprise have increased over the years as a result of good produce prices. Again, Sagoe *et al*. (2006) did not include contribution of leaves to total revenue per hectare of production therefore possibilities of understatement of benefits may arise.

Table 4.14 further shows that cocoyam production returned substantial net profit margin from sale of corms and leaves. The average cocoyam farmer earned GH¢ 4824 as net margin per hectare. The highest net margin (GH¢ 5744) was recorded by cocoyam producers in Fanteakwa, followed by GH¢ 4632 for producers in Asunafo North and GH¢ 4207.

Averagely, producers earned 24.1 percent on their farm investment per hectare of cocoyam farm. This implies that, all thing being equal, for any GH¢ 1.00 invested into cocoyam production, producers earned about GH¢ 0.24 more as return on capital. The rate of return on investment can be attributed generally to yield and the relatively high market price of corms and leaves. Covering about 95 percent of the total investment in farm assets for cocoyam production, land was the most expensive capital asset used by producers.

Comparatively, despite the labour-intensive nature of cocoyam, its production appears more profitable than other farm investments like cassava production with ROI of 23.6 percent (Chukwudji, 2008) and plantain production with return on investment of 12.6 percent according to Kasiine and Okoje (2014). However, the ROI for cocoyam production compares slightly lower to the prevailing cost of capital in Ghana which currently stands at about 25 percent (BoG, 2016) which implies that currently, the alternative use of capital may be more economically sound than its use in cocoyam production. This result disagrees with the findings of Sagoe *et al,* (2007).

**Table 4.15: Farm assets and ROI analysis of cocoyam production (hectare) by districts.**

| **Farm assets** | **VALUE OF ASSETS (GH¢) USED PER HA OF COCOYAM PRODUCTION (2014/2015)** | | | |
|---|---|---|---|---|
| | **Asante Akyem South** | **Asunafo North** | **Fanteakwa** | **Pooled** |
| Land | 4990 | 4002 | 3861 | 4284 |
| Equipment & Machinery Cutlass | 44 | 38 | 37 | 37.7 |
| Sacks | 25.2 | 30 | 40.8 | 34 |
| Baskets/pans | 66 | 50 | 57.5 | 55 |
| Hoes | 28.6 | 24 | 38 | 30 |
| Sprayer | 50 | 70 | 79 | 70 |
| **Total assets/investment [A]** | 5203.8 | 4214 | 4113.3 | 4510.7 |
| **Return on Investment Analysis** | | | | |
| Net Farm Profit [B] | 4207 | 4632 | 5744 | 4824 |
| Interest expenses | - | - | - | - |
| *Value of unpaid labour and management [C] | 3150 | 3600 | 4610 | 3787 |
| Return to assets (A-B) [D] | 1075 | 1032 | 1134 | 1037 |

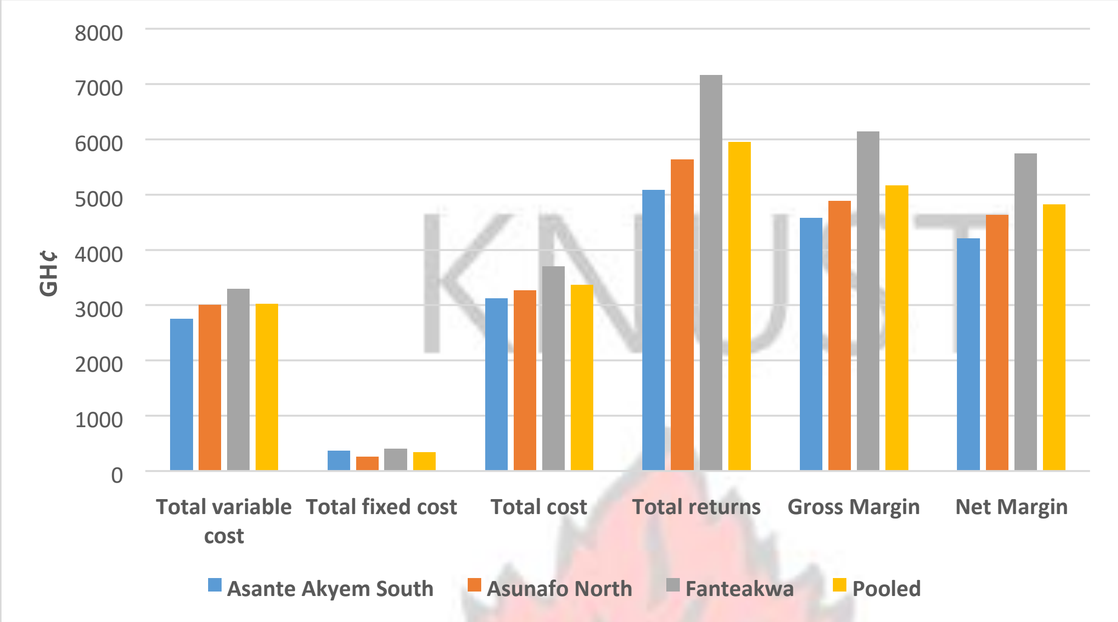
| | | | | |
|---|---|---|---|---|
| Rate of return on investment (ROI) (D/A)% | 20.3 | 24.5 | 27.6 | 24.1 |

* Values represent the opportunity costs for operator (household) labour and management on cocoyam farms for the various producing districts. GH¢ 1.00 = USD 0.29
Source: Author's Computation (2015).

In effect, even though cocoyam production may be profitable than other farm enterprises, investments may not earn enough to cover interests on loans with some left for expansion of the cocoyam enterprise when it is compared to the commercial interest rate of 25 percent. Differences in profitability levels were observed at the district levels. Disaggregated data on districts showed that profitability of production varied across districts with production in Fanteakwa being the most profitable with ROI of about 27.6 percent.
For every GH¢ 1.00 invested into cocoyam production, farmers in Asante Akyem South earned about GH¢ 0.20 more as profit while those in Asunafo North and Fanteakwa earned about GH¢ 0.25 and GH¢ 0.28 more respectively.

The differences in profitability across districts can be linked to the variation in costs of doing business as well as produce prices (cormels and leaves) in respective districts. This indicates that production in Fanteakwa is relatively more profitable followed by Asunafo North and Asante Akyem South respectively (Table 4.15). These results compare favourably with other studies that found that cocoyam production was generally profitable (Quaye *et al*., 2010; Ekunwe *et al*., 2015 and Okoye *et al*., 2006). The results further confirm findings by Onyeka (2014) that cocoyam production is profitable with a net return of over 100 percent of the total cost of production. Results compared to Quaye *et al*. (2010) who found the net revenue per hectare of cocoyam production to be $757, show that there has been an improvement in the profitability of cocoyam production in Ghana i.e. producing cocoyam has become more profitable over the years. Figure 4.4 exhibits the key costs, returns and margins of cocoyam production in the producing districts.

**Figure 4.4: Costs, returns and margins of cocoyam production in producing districts**




Source: Field Survey, 2015

Table 4.16 presents information on the various production costs incurred in cocoyam production under the two identified cropping systems i.e. sole cropping and intercropping systems. Details of prices and quantities used for estimation can be found at appendix II.

Generally, cultivation under the sole cropping system was more labour-intensive than the mixed cropping. The total labour cost per hectare under the sole cropping system was GH¢ 1850 whereas producers under the mixed cropping system incurred GH¢ 1726 as labour cost. Similarly, weeding and harvesting were the two most significant labour intensive activities for either of the cropping systems. Noticeably, producers under the mixed cropping system spent more on agrochemicals than farmers who cultivated cocoyam on sole crop basis.

**Table 4.16: Cost analysis on cocoyam production (hectare) by cropping system**

| **Cost Item** | **Average Value (GH¢)** | | |
|---|---|---|---|
| | **Sole cropping** | **Intercropping** | **Pooled** |
| **Variable cost** | | | |
| Labour costs | | | |
| Vegetation clearing & land preparation | 330 | 330 | 330 |
| Carting of planting | 60 | 70 | 66 |
| Planting & sett preparation | 300 | 345 | 330 |
| Weeding (3 times) | 525 | 450 | 495 |
| Spraying | 60 | 75 | 60 |

| | | | |
|---|---|---|---|
| Fertilization | 30 | 36 | 33 |
| Harvesting | 435 | 330 | 405 |
| Gathering/heaping | 110 | 90 | 99 |
| Total labour cost | 1850 | 1726 | 1818 |
| Corm setts | 300 | 225 | 243 |
| Herbicide | 77 | 112 | 108 |
| Fertilizer | 203 | 405 | 261 |
| Marketing costs | | | |
| Loading & Offloading | 102 | 55 | 57 |
| Market tolls/tickets | 60 | 50 | 52 |
| Carriage/transportation | 560 | 475 | 488 |
| Total marketing cost | 722 | 582 | 597 |
| **Total variable cost [A]** | **3152** | **3001** | **3027** |
| **Fixed costs** Land rent | 158 | 202 | 180 |
| Farm assets (cutlass, sacks, baskets) | 128 | 108 | 127 |
| Depreciation (hoes, sprayers) | 31 | 34 | 33 |
| **Total fixed cost [B]** | **317** | **344** | **340** |
| **Total cost (A+B)** | **3469** | **3345** | **3367** |

GH¢ 1.00 = USD 0.29

Source: Field Survey, 2015

The cost of agrochemicals (fertilizer and herbicides) for producers that cultivated cocoyam together with other crops on the same piece of land was about GH¢ 517 whereas cocoyam mono croppers spent averagely GH¢ 280 per hectare. This can be attributed to the fact that, cocoyam sole croppers were quite reserved at applying chemicals to cocoyam due to the perception that herbicides caused plants to wither and die while applying fertilizer reduced the storability of the corms. However, under the intercropping system, relatively more agrochemicals were applied apparently due to the fact that cocoyam was often not the main crop and that the main crops required agrochemicals to be applied to enhance productivity.

Averagely, producers under the sole cropping system spent more (GH¢ 3152) as total variable cost mainly due to high labour expenditure compared to intercropping system (GH¢ 3001). Farmers who intercropped cocoyam recorded an average revenue of GH¢ 7508 whereas mono croppers received GH¢ 8642 as total revenue per hectare (Table 4.16). Table 4.17 presents costs and returns of cocoyam production under the sole cropping and intercropping systems.

**Table 4.17: Costs and returns (profitability) analysis of cocoyam production (hectare) by cropping system**

| Item | Average Value (GH¢) | | |
|---|---|---|---|
| | Sole cropping | Intercropping | Pooled |
| Summary of costs | | | |
| Total variable cost [A] | 3152 | 3001 | 3027 |
| Total fixed cost [B] | 317 | 344 | 340 |
| Total cost [C] (A+B) | 3469 | 3345 | 3367 |
| **Cocoyam output** | | | |
| Quantity of corms harvested (kg) | 7042 | 5985 | 6515 |
| Selling price per kg (corms) | 1.14 | 1.1 | 1.13 |
| Quantity of leaves harvested (kg) | 439 | 746 | 592 |
| Selling price per kg (leaves) | 1.4 | 1.4 | 1.4 |
| **Revenue** Corms [D] | 8028 | 5386 | 7362 |
| Leaves | 615 | 1044 | 829 |
| Total returns [E] | 8643 | 7508 | 8191 |
| % contribution of leaves to total revenue | 7.1 | 19.4 | 11 |
| **Gross Margin (D-A) (corm only) [F]** | **4876** | **3463** | **4335** |
| **Gross Margin (E-A) [G]** | **5491** | **4507** | **5164** |
| **Net Income (D-C) (corm only)** | **4876** | **3463** | **3995** |
| **Net Income (E-C)** | **5174** | **4163** | **4824** |

GH¢ 1.00 = USD 0.29

Source: Field Survey, 2015

Under the intercropping system, producers benefited more revenue from cocoyam leaves than producers who cultivated cocoyam as a sole crop. About 19 percent of the revenue obtained from cocoyam production could be attributed to revenue from leaves under the intercropping system. Only seven percent of the revenue received by mono-croppers could be attributed to revenue from cocoyam leaves. The reason being that, farmers who cultivated cocoyam only on a piece of land usually did so for the corms. Therefore, such farmers harvest little to no cocoyam leaves at all for fear of reducing corm yield, hence the low yield of leaves. Cocoyam production was profitable under each of system but cultivating the crop as a monocrop was notably more profitable than cultivating it as an intercrop. Sole croppers recorded a gross margin of GH¢ 5491 compared to GH¢ 4507 for mixed croppers. Furthermore, the net margin for cultivating cocoyam as a sole crop was GH¢ 5174 and GH¢ 4163 for mixed croppers. Table 4.18 shows that the return on investment per hectare of cocoyam production under the two cropping systems.

**Table 4.18: Farm assets and ROI analysis of cocoyam production (hectare) by cropping system.**

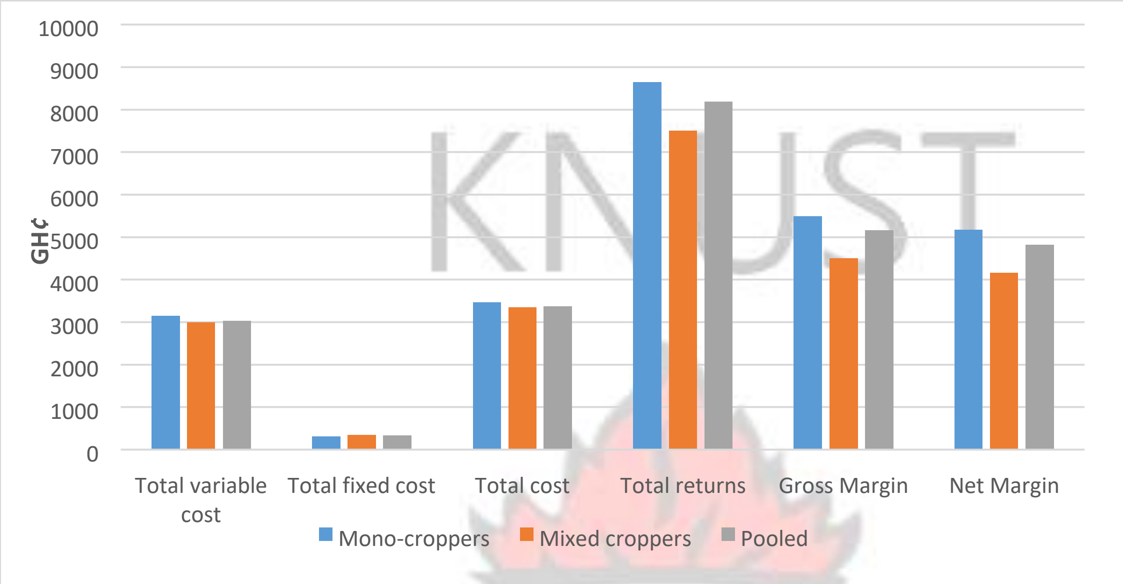
| Farm assets | VALUE OF ASSETS (GH¢) USED PER HA OF COCOYAM PRODUCTION (2014/2015) | | |
|---|---|---|---|
| | **Sole cropping** | **Intercropping** | **Pooled** |
| Land | 4284 | 4284 | 4284 |
| Equipment & Machinery Cutlass | 37.7 | 37.7 | 37.7 |
| Sacks | 34 | 34 | 34 |
| Baskets | 55 | 55 | 55 |
| Hoes | 30 | 30 | 30 |
| Sprayer | 70 | 70 | 70 |
| **Total assets/investment [A]** | 4510.7 | 4510.7 | 4510.7 |
| **Return to Investment Analysis** | | | |
| Net Farm Profit [B] | 5174 | 4163 | 4824 |
| Interest expenses | - | - | - |
| *Value of unpaid labour and management [C] | 3660 | 3268 | 3787 |
| Return to assets (A-B) [D] | 1514 | 895 | 1037 |
| Rate of return on investment (ROI) (D/A)% | 29.1 | 21.2 | 24.1 |

* Values represent the opportunity costs for operator (household) labour and management on cocoyam farms for the various cropping systems practised. GH¢ 1.00 = USD 0.29 Source: Author's Computation (2015).

The return on investment per hectare of cocoyam production under the mono-cropping system was about 29.1 percent while ROI under the intercropping system was 21.2 percent. This means that for every one Ghana cedi invested into producing cocoyam as a sole crop, farmers earned GH¢ 0.29 more as profit whereas producers practising the intercropping system earned GH¢ 0.21 more as profit for every cedi invested.

Summarily, the results confirms findings by Sagoe *et al.* (2006) which concluded that, given the two cropping systems, it was more profitable to cultivate cocoyam as a sole crop than as an intercrop when land is available. Therefore, cocoyam production is a worthwhile agricultural enterprise to undertake because returns accrued are able to cover costs and yield substantial profits for farmers. Figure 4.5 exhibits the key costs, returns and margins of cocoyam production under different cropping systems.

**Figure 4.5: Costs, returns and margins of cocoyam production under different cropping systems**




Source: Field Survey, 2015

### 4.6.1 Returns to other critical resources employed in cocoyam production (labour and management and land).

As already identified, the most significant sets of resources employed in cocoyam production comprise of the classical triad of capital, land and labour. Further analysis of the income statements were done at the various levels in this regard. With the return to capital already discussed, Table 4.19 below shows results of the returns to land as well as farmers' labour and management.

**Table 4.19: District wise assessment of returns to labour and management and land in cocoyam production.**

| | Average value (GH¢) | | | |
|---|---|---|---|---|
| **Item** | **Asante Akyem South** | **Asunafo North** | **Fanteakwa** | **Pooled** |
| Land | 4990 | 4002 | 3861 | 4284 |
| Total capital | 5203.8 | 4214 | 4113.3 | 4510.7 |

| | | | | |
|---|---|---|---|---|
| Net Farm Profit | 4207 | 4632 | 5744 | 4824 |
| Opportunity cost of unpaid labour & mgt | 3150 | 3600 | 4610 | 3787 |
| Opportunity cost of capital (@ 25%) | 1301 | 1053.5 | 1028.3 | 1127.7 |
| Total capital less land | 213.8 | 212 | 252.3 | 226.7 |
| Opportunity cost of capital less land | 53.5 | 53 | 63 | 56 |
| Return to land | 1003.6 | 979 | 1070.9 | 980.3 |
| Return to unpaid labour & mgt | 2906.1 | 3578.5 | 4715.7 | 3696.3 |
| Return to per unit (day) unpaid labour & mgt | 20.8 | 23.9 | 29.5 | 24.6 |

Source: Author's Computation (2015)

The result shows that the return to agricultural lands committed to cocoyam production averaged GH¢ 980.3 per hectare. The return to land received by producers in Asante Akyem South (GH¢ 1003.6) per hectare of cocoyam compares similarly with the return on land obtained by cocoyam producers in the Fanteakwa District (GH¢ 1070.9). Interestingly, the return to land for farmers in Asunafo North was relatively lower (GH¢ 979) compared to the other districts. Competition for land for cash crop cultivation like cocoa has driven up the value of agricultural land in Asante Akyem and Asunafo North hence a higher opportunity cost of land in these areas. This result emphasises the significance of land to the profitability of cocoyam production. Therefore, coupled with the relatively low yield of cocoyam, the returns to land in these areas compare lower to that of Fanteakwa. Compared with per hectare average rent of GH¢ 180 as shown in Table 4.16, cocoyam farmers are better of cultivating cocoyam than if they had rented out their lands.

Farmers earned an average of GH¢ 3696.3 for the 2014/2015 cropping season as return to family labour and management after subtracting the opportunity cost of capital (25 percent of the total cost of capital). As expected, producers in Fanteakwa earned significantly high returns on farmer's labour and management (GH¢ 4715.7) than those in Asunafo North (GH¢ 3578.5) whereas farmers in Asante Akyem South earned GH¢ 2906.1 as returns to their own labour and management for the period. This implies that farmers averagely earned GH¢ 24.6 per day as returns to labour and management ability. Compared to the average wage rate of the pooled sample i.e. GH¢ 13 (see appendix II) and the prevailing minimum wage rate of GH¢ 7, farmers earned more on their efforts than they would have if they had worked on other on or off-farm enterprises. McConnell and Dillon (1997) stated that it is practically difficult to distinguish management ability from farmer's labour in smallholder agricultural enterprises. Therefore, the estimated returns to labour and management is naturally expected to be higher than the prevailing wage rates. This is so because wage rates give information on the opportunity cost of labour alone and not on management ability.

The returns to own labour and management for the specific districts translates into GH¢ 20.8, GH¢ 23.9 and GH¢ 29.5 per day for producers in Asante Akyem South, Asunafo North and Fanteakwa districts respectively. Compared to the average wage rates of GH¢ 15, GH¢ 12 and GH¢ 13 for Asante Akyem South, Asunafo North and Fanteakwa respectively, the return to labour and management for cocoyam production was higher indicating that cocoyam producers benefited more from cultivating cocoyam than looking for off farm work. The return to labour and management was found to be higher where the average cost of labour was lower (see appendix III) and the yield of cocoyam was relatively higher confirming that labour and yield are crucial variable to cocoyam profitability.

Table 4.20 also explores the returns to own labour and management as well as land on the basis of the cropping systems practised. Analysis based on the cropping systems revealed that producers who cultivated the root crop on a sole crop basis earned GH¢ 1457.3 as returns to (per hectare) land committed to growing cocoyam. The return to a hectare of land for famers who cultivated cocoyam as an intercrop averaged GH¢ 838.3. Thus, a profit of GH¢ 838.3 was recorded for farmers using their lands to cultivate cocoyam as an intercrop, signifying positive land productivity similar to the sole cropping system.

**Table 4.20: Assessment of returns to labour and management and land in cocoyam production per cropping system.**

| | **Average value (GH¢)** | | |
|---|---|---|---|
| **Item** | **Sole cropping** | **Intercropping** | **Pooled** |
| Land | 4284 | 4284 | 4284 |
| Total capital | 4510.7 | 4510.7 | 4510.7 |
| Net Farm Profit | 5174 | 4163 | 4824 |
| Opportunity cost of unpaid labour & mgt | 3660 | 3268 | 3787 |
| Opportunity cost of capital (@ 25%) | 1127.7 | 1127.7 | 1127.7 |
| Total capital less land | 226.7 | 226.7 | 226.7 |
| Opportunity cost of capital less land | 56.7 | 56.7 | 56.7 |
| Return to land | 1457.3 | 838.3 | 980.3 |
| Return to unpaid labour & mgt | 4046.3 | 3035.3 | 3696.3 |
| Return to per unit unpaid labour & mgt | 25.3 | 21.7 | 24.6 |

Source: Author's Computation (2015)

However, the relatively low return to land under the intercropping system can be attributed to production inefficiencies and the seeming lack of proper resource allocation under the cropping system. Averagely, the returns to labour and management for farmers who cultivated cocoyam as a sole crop was GH¢ 4046.3 which translates into GH¢ 25.3 per day. Cocoyam cultivated as an intercrop returned and amount of GH¢ 3035.3 to farmer's own labour and management which also translates into GH¢ 21.7 daily.

### 4.7 Analysis of constraints of small-scale cocoyam producers

Cocoyam producers are faced with myriad of constraints which directly and indirectly weigh down on production improvement and livelihood of producing households. Table 4.19 provides farmers' rating of the various constraints based on five-point Likert scale.

#### 4.7.1 Production, socio-economic and marketing constraints of cocoyam production

According to Table 4.21, the most constraining production related factor was 'high cost of labour' with a mean score of 4.38 signifying that cocoyam producers generally agree that the high cost of labour is a major constraint. Secondly, with a mean score of 4.09, cocoyam farmers generally agreed that 'high incidence of weeds' was the second most important production constraint whereas high of labour intensity in cultivation was the third most important production constraint with a mean score of 3.75. Producers further agreed (mean score = 3.75) that the fourth most important production constraint was limited access to suitable land

Producers were generally indifferent towards scarcity of labour and low soil fertility (mean scores of 3.0 and 2.8 respectively representing neutral) as important production related constraints.

**Table 4.21: General constraints facing small-scale cocoyam producers**

| Constraint | Strongly agree (5) | Agree (4) | Neutral (3) | Disagree (2) | Strongly disagree (1) | Mean score (rank)* |
|---|---|---|---|---|---|---|
| **Production related** | | | | | | |
| High cost of labour | 94 (62.7)* | 34 (22.7) | 11 (7.3) | 8 (5.3) | 3 (2) | 4.38 [1] |
| High incidence of weeds | 71 (47.3) | 49 (32.7) | 10 (6.7) | 12 (8) | 8 (5.3) | 4.09 [2] |
| High labour intensity | 51 (34) | 28 (18.7) | 53 (35.3) | 10 (6.7) | 8 (5.3) | 3.79 [3] |
| Limited access to suitable land | 68 (45.3) | 34 (22.7) | 4 (2.7) | 15 (10) | 29 (19.3) | 3.75 [4] |
| Labour scarcity | 29 (19.3) | 28 (18.7) | 39 (26) | 23 (15.3) | 31 (20.7) | 3.00 [5] |

| | | | | | | |
|---|---|---|---|---|---|---|
| Low soil fertility | 13 (8.7) | 36 (24) | 22 (14.7) | 41 (27.3) | 38 (25.3) | 2.83 [6] |
| Category Mean | | | | | | 3.64 |
| **Socio-economic related** | | | | | | |
| High perishability of leaves | 103 (68.7) | 21 (14) | 16 (14) | 7 (4.7) | 3 (2) | 4.42 [1] |
| Inadequate capital to invest | 96 (64) | 29 (19.3) | 4 (2.7) | 10 (6.7) | 11 (7.3) | 4.26 [2] |
| Limited access to credit | 92 (61.3) | 26 (17.3) | 13 (8.7) | 9 (6) | 10 (6.7) | 4.21 [3] |
| High interest rate on available credit | 90 (60) | 26 (17.3) | 19 (12.7) | 4 (2.7) | 11 (7.3) | 4.20 [4] |
| Category mean | | | | | | 4.37 |
| **Marketing related** | | | | | | |
| Unpredictability of produce price | 52 (34.7) | 78 (52) | 14 (9.3) | 3 (2) | 3 (2) | 4.15 [1] |
| Poor road infrastructure | 85 (56.7) | 27 (18) | 9 (6) | 18 (12) | 11 (7.3) | 4.04 [2] |
| High cost of transport to market | 70 (46.7) | 35 (23.3) | 16 (10.7) | 9 (6) | 20 (13.3) | 3.84 [3] |
| Low prices in accessible markets | 51 (34) | 46 (30.7) | 35 (23.3) | 11 (7.3) | 7 (4.7) | 3.82 [4] |
| Category mean | | | | | | 3.96 |
| Overall Constraint Score | | | | | | 3.91 |
| Krippendorff's Alpha (Kα) | **0.54** | | LL95%CI=0.4901 | | UL95%CI=0.545 | |

*Figures in parentheses are percentages of responses
*Superscripts represent the rank of respective constraints based on their mean scores Source: Field Survey, 2015.

Results are consistent with findings of Quaye *et al*. (2010) which found that labour intensity and its attendant high cost are the most critical production constraints. Furthermore, Talwana *et al*. (2009) and Serem *et al*. (2008) also highlights land scarcity, diseases and incidence of weeds as the top three critical production constraints. However, Ekunwe *et al*. (2014) found incidence of diseases and pests as the most pressing production constraint for cocoyam producers.

The most pressing socio-economic constraint was the high perishability of cocoyam leaves harvested. All producers strongly agreed to this with a mean score of 4.42. Farmers generally agreed (mean score = 4.26) that the second most important socio-economic related constraint was the inadequacy of capital to invest in cocoyam production. Limited access to credit was generally agreed to and ranked as third most significant socio-economic constraint hampering production.

The fact that produce prices were often not predictable (fluctuated frequently) was generally agreed by respondents as the most pressing marketing constraint that hampers cocoyam production (mean score = 4.15). Secondly, the lack of proper road infrastructure to aid transportation of produce to market centres was ranked as the second most important marketing constraint (mean score of 4.04). Cocoyam producers further agreed (mean score = 3.84) that the third most pressing marketing constraint hampering cocoyam production was the high costs associated with transporting cocoyam produce to accessible market centres. With a means score of 3.82, low produce price in accessible markets was ranked as fourth most important marketing constraint hampering cocoyam production.

Similarly, Quaye *et al*. (2010) found limited access to credit as a major socio-economic constraint for producers whereas Ijioma *et al*. (2014) and Ekunwe *et al.* (2014) also found inadequate finance to invest into cocoyam production as the second most important constraint facing cocoyam producers in Anambra State, Nigeria.

Table 4.21 further reveals that with a category mean score of 4.37, cocoyam producers were more constrained by socio-economic factors of production than marketing and production related constraints. Marketing factors were the second most pressing category of constraints with a category mean score of 3.96 whereas production related constraints (category mean = 3.64) were the least pressing set of constraints militating against cocoyam production according to the farmers. Additionally, a Krippendorff's Alpha statistic of 0.54 showed a moderate level of concordance amongst respondents in the rating of constraints hampering production.
The results compares favourably with Quaye *et al*. (2010) and Ijioma *et al*. (2014) who also found high cost of transportation and poor feeder roads as part of the critical marketing constraints faced by cocoyam producers. However, these constraints are not necessarily unique to cocoyam production considering findings from Odendo *et al.* (2001), Hillocks *et al*. (2002) and Schill *et al*. (2000). These studies also found that low soil fertility, liquidity problems, labour scarcity, high labour cost for weeding and market related issues as critical constraints hampering maize, cassava and also plantain production.

Table 4.22 presents a summary of scores and rankings of constraints specific to producing districts. Details on percentages and rankings can be found at appendix IV. Regarding production constraints specific to producers in Asante Akyem South, the high labour requirement of cultivating cocoyam was considered the most constraining factor since cocoyam producers strongly agreed (mean score of 4.5).

Subsequently, with a mean score of 4.1, high cost of labour was ranked as second most important production related constraint by cocoyam producers in the Asante Akyem South district. A mean score of 3.8 and 3.7, showed that producers ranked high incidence of weeds and access to cultivable land as third and fourth most significant constraints hampering cocoyam production in the district. With mean scores of 2.7 (representing neutral) farmers in the district were indifferent towards scarcity of labour as a production related constraint whiles disagreeing to low soil fertility (mean score of 2.3) as an important production related constraint in the district (Table 4.22).

Table 4.22 further reveals that in terms of socio-economic related constraints, the most significant to the farmers was high interest rates on available credit with a mean score agreement level of 4.4. The second most important socio-economic constraint (mean score of 4.3) according to producers in the district related to short shelf life of cocoyam leaves harvested. Farmers also rated inadequacy of capital to invest in cocoyam production as the third most constraining socio-economic factor (means score of 4.1) hampering production. Limited access to credit was generally agreed and ranked as the fourth most pressing socio-economic constraint given a mean score level of agreement of 4.21. High costs associated with transporting both corms and leaves to accessible market centres and produce price fluctuations were generally agreed and ranked by respondents as the joint topmost marketing constraints (mean score = 4.4).

However, respondents rated lack of proper road infrastructure to aid transportation of produces to market centres as the third most important marketing constraint according to a mean score of 4.2. Again, with a mean score of 3.6, cocoyam farmers in Asante Akyem district ranked low produce price in accessible markets as the fourth most important marketing constraint hampering cocoyam production.

**Table 4.22: Constraints of cocoyam production in producing districts**

| **Constraint** | **Mean constraint scores (ranks)** | | |
|---|---|---|---|
| | **Asante Akyem South** | **Asunafo North** | **Fanteakwa** |

| Production related | Mean score | Rank | Mean score | Rank | Mean score | Rank |
|---|---|---|---|---|---|---|
| High labour intensity | 4.5 | 1 | 3.5 | 4 | 3.6 | 4 |
| High cost of labour | 4.1 | 2 | 4.4 | 2 | 4.3 | 1 |
| High incidence of weeds | 3.8 | 3 | 4.6 | 1 | 4.0 | 2 |
| Limited access to suitable land | 3.7 | 4 | 4.1 | 3 | 3.9 | 3 |
| Labour scarcity | 2.7 | 5 | 3.5 | 4 | 3.4 | 5 |
| Low soil fertility | 2.3 | 6 | 2.5 | 5 | 3.1 | 6 |
| Category mean | 3.52 | | 3.77 | | 3.72 | |
| **Socio-economic related** | | | | | | |
| High interest rate on available credit | 4.6 | 1 | 4.6 | 2 | 4.4 | 2 |
| High perishability of leaves | 4.3 | 2 | 4.7 | 1 | 4.3 | 3 |
| Inadequate capital to invest | 4.1 | 3 | 4.2 | 4 | 4.5 | 1 |
| Limited access to credit | 3.7 | 4 | 4.4 | 3 | 4.3 | 3 |
| Category mean | 4.18 | | 4.48 | | 4.38 | |
| **Marketing related** | | | | | | |
| High cost of transport to | 4.4 | 1 | 4.1 3 | 3 | 3.0 | 4 |
| Unpredictability of produce price | 4.4 | 1 | 4.7 1 | 1 | 4.1 | 2 |
| Poor road infrastructure | 4.2 | 3 | 4.3 2 | **2** | 3.7 | 3 |
| Low prices in accessible markets | 3.6 | 4 | 3.6 4 | 4 | 4.3 | 1 |
| Category mean | 4.15 | | 4.18 | | 3.78 | |
| Overall Constraint Score | 3.89 | | 4.09 | | 3.92 | |
| Krippendorff's Alpha (Kα) | 0.51 | | 0.62 | | 0.44 | |
| | LL95%CI=0.523; UL95%CI=0.585 | | LL95%CI=0.448; UL95%CI=0.688 | | LL95%CI=0.362; UL95%CI=0.427 | |

Source: Field Survey, 2015.

On the other hand, with a category mean score of 4.18 indicating the highest mean constraint score and degree of importance of constraints' category, cocoyam producers were more constrained towards socio-economic related factors of production. Marketing related factors were the second most pressing category of constraints with a category mean score of 4.15 whereas production related constraints (category mean = 3.52) were the third pressing set of constraints militating against cocoyam production according to the farmers.

Additionally, a Krippendorff's Alpha statistic of 0.51 also showed a moderate level of agreement amongst respondents in the district in the ranking of constraints hampering production. Producers in Asunafo North district indicated that high incidence of weeds on cocoyam farms was the most significant production related problem militating against production (mean score of 4.6) followed by high cost of labour (mean score = 4.4) and access to cultivable land (mean score = 4.1) as second and third most relevant production constraint. Scarcity of labour and high labour requirement of production were jointly ranked as the fourth most significant constraint whereas cocoyam producers were indifferent towards low soil fertility (means score of 2.5 representing neutral) as a production related constraint.

According to cocoyam producers in Asunafo North, the most pressing socio-economic related constraint was high perishability of cocoyam leaves harvested. All producers strongly agreed to this with a mean score of 4.7. Producers agreed (mean score = 4.6) that the second most important socio-economic related constraint was high interest rates on available credit while limited access to credit was agreed and ranked as third most relevant socio-economic constraint militating against production.

Inadequate of capital to invest in cocoyam production was also ranked as the fourth most significant socio-economic constraint hampering production given a mean score of 4.2. Similar to Asante Akyem South, the fact that produce prices were often not predictable was generally ranked by respondents as the topmost marketing constraint that hampers cocoyam production (mean score = 4.7). Also, poor road infrastructure (i.e. the lack of it and even deplorable states of existing ones linking to market centres) was ranked as second most important marketing constraint given a mean score of 4.3. Consequently, producers further agreed (mean score = 4.1) that the third most pressing marketing constraint hampering cocoyam production was the high costs associated with transporting cocoyam produces to accessible market centres.

A mean score of 3.6 indicates that low produce prices in accessible markets considered the fourth most important marketing constraint hampering cocoyam production in Asunafo North. Similar to the mean scores rankings of category by cocoyam producers in the Asante Akyem district, table 4.22 shows that with a category mean score of 4.48, signifying the highest mean constraint score and degree of importance of constraint's category, cocoyam producers in Asunafo North were also more constrained towards socio-economic related factors of production.

Marketing related factors were rated second most pressing set of constraints with a category mean score of 4.18 whereas production related constraints (category mean = 3.77) were ranked the third most pressing set of constraints militating against cocoyam production according to the farmers. Furthermore, a Krippendorff's Alpha statistic of 0.62 showed a strong level of concordance amongst respondents in the rating of the constraints.

Farmers in Fanteakwa district ranked of high cost of labour as the most important production related set back in the district with a mean score of 4.0. Unsurprisingly, the second most relevant production constraint with a mean score of 4.4, cocoyam farmers generally agreed to high incidence of weeds as the second most important production constraint whereas access to cultivable land was ranked as the third most important production constraint with a mean score of 3.9.

Producers further agreed (mean score = 3.6) that the fourth most important production constraint was the high nature of labour intensity in cultivation. Meanwhile, farmers were indifferent (neutral) towards production related constraints like scarcity of labour and low soil fertility ranked as fifth with mean scores of level of agreement being 3.4 and 3.1 respectively. Table 4.22 reveals first and foremost that the topmost socio-economic related constraint according to respondents in the district had to do with inadequate of capital to invest in cocoyam production.

Cocoyam farmers ranked it topmost with a mean score of 4.5 signifying that producers strongly agreed to the constraint. Subsequently, high interest rates on available credit was generally agreed by farmers as the second most important socio-economic constraint facing cocoyam farmers with a mean score of 4.4 whereas limited access to credit and high perishability of cocoyam leaves were jointly rated as the fourth most significant socio-economic constraint. Regarding marketing constraints, producers in the Fanteakwa district agreed and ranked low produce price in accessible markets, the most significant of all marketing constraints with a mean score of 4.3.

Again, unpredictability of produce prices was generally agreed by respondents as the second most significant marketing constraint (mean score = 4.1). Lack of proper road infrastructure to aid transportation of produces to market centres was further rated third most important marketing constraint with a mean score level of agreement of 3.7. Farmers were however indifferent (mean score = 3.0) to high costs associated with transporting cocoyam produces to accessible market centres as a marketing constraint.

With a category mean score of 4.38 indicating the highest mean constraint score, cocoyam producers were also more constrained towards socio-economic related factors of production. Marketing related factors were the second most pressing category of constraints with a category mean score of 3.78 whereas production related constraints (category mean = 3.72) were the least pressing set of constraints militating against cocoyam production according to the farmers.

Additionally, a Krippendorff's Alpha statistic of 0.44 showed a moderate level of concordance amongst respondents in the rating of constraints hampering production.

# CHAPTER FIVE

# 5.0 SUMMARY, CONCLUSION AND POLICY RECOMMMENDATIONS

## 5.1 Introduction

The chapter presents a summary, conclusions and policy recommendations of the study. The chapter has been sectioned into three parts. First is a section on the summary of major findings of the study. The second section further presents the study's conclusions while the last section talks about some policy recommendations flowing from the study.

## 5.2 Summary of the main findings

This study sought to specifically investigate determinants and profitability of cocoyam production in Ghana as well as examine the production, marketing and socio-economic constraints hampering cocoyam production in order to guide future policy and strategy formulation. The study focused on the three most important growing districts of cocoyam in Ghana, drawing succinct responses from a total of 150 farmers across Asante Akyem South, Asunafo North and Fanteakwa districts through the use of structured questionnaires. Estimation of production functions were done by employing the Stochastic Frontier Approach (SFA) to ascertain determinants of cocoyam production. Gross margin and return on investment analysis were used to assess the profitability of cocoyam production. Likert scale ranking and the Krippendorff's Alpha Reliability Test were employed to examine constraints faced in cocoyam production.

The results indicate that the mean age and farming experience of farmers were 48 years and 15 years respectively. Majority of the cocoyam producers had their own farmlands (54 percent), had attained at least basic education (66.7 percent) and were females (56 percent) even though 78 percent of cocoyam producers interviewed in the Fanteakwa district were males. Majority of the farmers cultivated cocoyam equally for household consumption and for sale but the target produce for sale was basically the corms. The results also show that cocoyam was predominantly cultivated as an intercrop (84 percent) with plantain, cocoa and cassava. About 20 percent of producers in Fanteakwa and Asunafo North districts planted cocoyam as pure stand (sole-cropping).

The average cocoyam area under cultivation was 0.55 hectares and this represented about 19 percent of the total cultivated land by cocoyam producers for the 2013/2014 cropping season and about 13 percent of the total agricultural land controlled by the farmers. However, cocoyam farm sizes were larger in Fanteakwa Districts and relatively smaller in Asante Akyem South Districts.

The study further shows that corm yield was about 6.5mt/ha whereas cocoyam leaves yield was about 0.59mt/ha. The corm yield under the mono-cropping system (7mt/ha) was significantly higher at 1 percent than the yields under intercropping system. However, leaves yield under the sole cropping system (0.44mt/ha) was found to be significantly lower at 1 percent, than leaves yield under the intercropping system (0.75mt/ha). Corm and leaves yield were found to differ across producing districts in Ghana. Producers in Fanteakwa recorded higher corm and leaves yield and those in Asante Akyem recorded relatively lower yields for both corms and leaves.

The Cobb Douglas stochastic production model estimated shows that labour, land area cultivated, quantity of setts planted and costs incurred on other inputs i.e. fertilizer and fungicides positively influenced cocoyam production significantly at 5 percent levels. The total input elasticity of 0.484 indicates that there is, generally, decreasing returns to scale in cocoyam production in Ghana.

Furthermore, the cultivation under sole cropping system, male gender, extension contact, education, farming experience and household size also had a significant positive effect on cocoyam production. However, the amount of cocoyam leaves harvested, herbicide application and continuous cultivation on the same piece of land had a significant negative effect on corm production. Determinants of production at the district level revealed that household size were not significant in Asante Akyem South whereas amount of leaves harvested and herbicide application were not significant in Fanteakwa. Off-farm income positively affected corm production in Asunafo North. Generally, cocoyam producers were found to be producing within the economic region of production (stage II). However, more specifically, production in Asante Akyem South and Asunafo North exhibited increasing returns to scale while production in Fanteakwa exhibited decreasing returns to scale.

Labour was found to be the most important cost component. It accounted for more than half (54 percent) of the total cost of production in cocoyam production with harvesting and weed control among the most labour-intensive activities of cocoyam production.
Cocoyam production returned an average gross margin of GH¢ 5164 and net farm profit of GH¢ 4824 per hectare during the 2013/2014 cropping season. It was found that revenue accrued from the sale of cocoyam leaves accounted for 11 percent of the total cocoyam revenue. This translates into a return on investment (ROI) of 24 percent suggesting that the enterprise is relatively profitable than similar farm investments like cassava and plantain production but not

as profitable compared to commercial interest rate of 25 percent. Any one Ghana cedi invested into cocoyam production returned a net profit of GH¢ 0.24 *ceteris paribus*. Meanwhile, production in Fanteakwa and Asunafo North was found to be profitable with ROI of about 27 percent and 25 percent than production in Asante Akyem South with a return on investment of about 20 percent which compares lower than commercial interest rate.

Furthermore, the study found that producing cocoyam as a sole crop was relatively more profitable than under the intercropping system. Producers who cultivated cocoyam on a sole crop basis earned average gross margin and net margin of GH¢ 5491 and GH¢ 5174 respectively translating into a ROI of about 29 percent whereas farmers that produced cocoyam as an intercrop earned GH¢ 0.21 more as profit for any one Ghana cedi invested. Revenue from cocoyam leaves accounted for 19 percent of the total cocoyam revenue earned under the intercropping systems compared to about seven percent for sole croppers.

Producers earned an average of GH¢ 980 and 3696 per hectare per cropping season, as returns to land as well as unpaid labour and management respectively with producers from Fanteakwa district receiving relatively higher returns to these resources. This compared higher than the prevailing rent per hectare of agricultural land indicating that it is economically prudent cultivating cocoyam than renting out the lands. Similarly, farmers who cultivated cocoyam as a sole crop averagely earned GH¢ 25.3 per day as returns to labour and management whereas producers who intercropped cocoyam earned about GH¢ 21.7 as returns on family labour and management daily. The estimated returns to labour and management also compared higher than the present wage rates across the districts. This also shows positive productivity in labour hence, producers have a better financial leverage for their labour when they cultivate cocoyam than to work on other on or off-farm enterprises.

With a Krippendorff Alpha statistic of 0.54 indicating a moderate level of concordance amongst cocoyam producers, farmers were mostly constrained by socio-economic factors such as inadequate capital to invest, limited access to credit and high perishability of harvested leaves. The second category of constraining factors were market related issues like unpredictability of produce prices, poor road infrastructure and high cost of transportation.  High cost of labour, incidence of weeds, high labour intensity and limited access to suitable land were identified as the most pressing production constraints faced by farmers. However, production, socioeconomic and marketing constraints within districts slightly differed in terms rankings by producers.

## 5.3 Conclusions

Based on the findings, the study concludes that cocoyam cultivation is generally done on a small scale at an average of 0.55 hectares per cropping season which is about 13 percent of the total agricultural land managed by producing households and about 19 percent of the total cultivated land of cocoyam producers.

The root crop, whose main target produce is the corms, is cultivated equally for household consumption and for sale and mostly used as an intercrop to plantain, cocoa and cassava. The scale and yield of cocoyam differ markedly across major producing districts in Ghana, with production being dominant in Fanteakwa.

Also the study concludes that corm yields are higher under mono-cropping system compared to the mixed cropping system *ceteris paribus*. Input factors like labour, quantity of corm setts planted, land area cultivated and costs incurred on other factors of productions are the key determinants of cocoyam production in Ghana. Also, mono-cropping system, male gender, extension contact and farming experience have significant positive effect on corm output. However, herbicide usage, quantity of leaves harvested as well as continuous cropping on the same piece of land without fallow or fertilization have a significant negative impact on corm output thereby contributing to reduction in production volumes.

The study concludes that with a net margin of GH¢ 4824 and a rate of return on investment of about 24 percent, cocoyam production is not so profitable under the present economic conditions probably suggesting the recent shift of producers from its cultivation. All things being equal, producers will earn GH¢ 0.24 as profit for every one Ghana cedi invested into cocoyam production. The rate of return on cocoyam investment is relatively lower than the cost of capital in Ghana (25 percent) and thus production may not be exactly attractive financially to entrepreneurs. Debt financing in cocoyam enterprise may also be a little risky since investments may not earn enough to cover interests on debts.

However, producers in Fanteakwa and Asunafo North have a comparative advantage than those in Asante Akyem South district given the levels of profitability across the districts. Also, based on cocoyam returns, production is relatively more profitable under sole cropping system than when it is intercropped. Producers relatively earn higher returns to other critical resources like land and labour and management compared to the opportunity cost of agricultural land and labour and management.

The most important production related constraints hampering cocoyam production are high cost of labour, high incidence of weeds, high labour intensity of production and limited access to suitable land. The most significant socio-economic constraints hampering production include high perishability of cocoyam leaves harvested, inadequate capital to invest, limited access to credit and high interest rate on available credit.

With respect to marketing constraints unpredictability of produce prices (unpatterned fluctuations), poor road infrastructure, high cost of transporting produces to market centres and low produce prices in accessible markets were ranked by farmers. Producers fairly agreed to these constraint according to Krippendorff's Alpha statistic of 0.54. Production, marketing and other socio-economic constraints are however district characteristic in nature.

## 5.4 Recommendations

### 5.4.1 Policy recommendations

The following are policy recommendations that the study proposes based on the findings.

1. Given the challenge of land and labour, the study recommends intensification of market inputs such as improved planting materials and fertilizer especially in Asante Akyem South and Asunafo North since that has a resultant potential of increasing cocoyam output and income thereby making farmers more competitive and profit-maximizing. The use of improved planting materials (early maturing and high yielding) is crucial to ensuring the profitability of cocoyam in Ghana. The study recommends development and distribution of improved cocoyam cultivars for farmers to adopt and improve production. Policies directed at encouraging and improving access and usage of productive resources should therefore be considered.

2. Cocoyam production involves capital injection and access to more productive resources. Improving and promoting cultivation of the crop cannot be continuously left in the hands of resource poor farmers (mostly women) alone. Traditionally, men have more access to productive resources than women. The study proposes that more men be encouraged to get involved in cocoyam production through education and periodic sensitization about the profitability and economic prospects of the crop. An increased participation of men in the cocoyam subsector will increase production. Also, other

entrepreneurs should be encouraged to venture into cocoyam production especially in Fanteakwa and Asunafo districts since it is relatively more profitable to produce there.

3. In order to increase yield and advance cocoyam production in Ghana, the study recommends the sole cropping of cocoyam over the intercropping system. This does not suggest a wholesale elimination of the mixed cropping systems across cocoyam growing communities. Farmers who often intercrop cocoyam can henceforth be encouraged to allot similar portions of their cultivated lands (as they used to under intercropping system) to sole cropping cocoyam. This way, they still get to cultivate a cocktail of crops which ensure household food security and spread risk while improving yield and income from cocoyam.

4. The Ministry of Food and Agriculture, development partners and other stakeholders of the root and tuber subsector must promote and incentivise cultivation of cocoyam as pure stand so as to increase yield and income from cocoyam for producers. In this regard, a re-introduction of the regulated rotational strategy for using secondary forest lands for food crop production under the Modified Taungya System (MTS) across the transitional zones of Ghana is recommended to boost cocoyam production in the country.

   Furthermore, the re-institution of such a system (MTS) affords cocoyam producers the opportunity to reduce the incidence of continuous cropping without fallow on some farmlands due to increased access to land especially in Asante Akyem. Given that continuous cropping of the same piece of land without adequate nutrient replenishment scheme affects production of cocoyam negatively, the study recommends an end to this practise of continuous cropping so as to improve per capita output of cocoyam farmers.

5. Herbicide application, according to the results affects yield negatively. The study proposes no or minimal application of herbicides on cocoyam farms. In the scenario where herbicides will need to be applied as a result of labour constraints, the study further proposes extensive farmer training programmes regarding suitable herbicides that pose little harm to sprouting cocoyam, appropriate timing of application and appropriate methods of applications so as to minimize the effect of herbicide application on yield. Applying recommended herbicides using recommended application rates and

procedures will help reduce labour intensity of production. The cost of production will therefore be critically minimised thereby enhancing profit levels of producers.

6. The study also recommends an improved access to extension services by cocoyam famers to increase yield. It can be done by employing more human resource for agricultural extension work or by tasking some extension workers to pay particular attention to cocoyam producers in producing districts. Through this, recent agricultural technologies and innovations can be passed on to cocoyam farmers for adoption so as to improve yields and income.

7. The study found a negative relationship between cocoyam leaves harvested and corm yield. It is recommended that leaves harvesting for sale or consumption be avoided where cormels are considered the main economic part. Cocoyam farmers should be sensitized to plant small areas of their farms solely for leaves harvesting so that the main farms will be left for cormel production.

   Again, other farmers can also be encouraged to go into production of only cocoyam leaves to serve as a source of supply of leaves to the market. That way, farms meant for cormel production will be freed from leaves harvesting to ensure high yield.

8. The study proposes the development of cost-effective harvesting technologies easily adoptable by small scale cocoyam producers to make harvesting of cocoyam easier and less labour-intensive. This will go a long way to reduce total cost of production and improve income of producing households.

**5.4.2 Recommendations for further research**

1. The study recommends detailed experimental research on the impact of herbicide application on productivity of cocoyam in Ghana. The study will unearth vital information that will inform policy decisions and practises regarding the types of herbicides that may be appropriate as well as the methods and timings of herbicide application on cocoyam farms.

2. Lastly, also recommends further research into the relative competitiveness (profitability) between cocoyam production and the production of other crops often used as intercrops with cocoyam. Such a study will inform farmers and other entrepreneurs about these crops that compete for similar production factors so as to guide them in their investment decisions.



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# APPENDICES

## APPENDIX I: Output and yield results

### 1. Output and yield for corms and leaves harvested under different cropping system and districts

| | AAS | AN_D | F_D | Pooled |
|---|---|---|---|---|
| **Cocoyam farm size (hectares)** | | | | |
| Mean | 0.38 | 0.77 | 0.84 | 0.55 |
| Std. Dev. | 0.14 | 0.29 | 0.38 | 0.21 |
| CV (%) | 36.84 | 37.66 | 45.24 | 38.18 |
| **Cocoyam output (corms) (kg)** | | | | |
| Mean | 2292.6 | 5101.1 | 5773.3 | 3883.3 |
| Std. Dev. | 1094.4 | 2101.6 | 1984.8 | 1595.2 |
| CV (%) | 47.74 | 41.20 | 34.38 | 41.02 |
| **Cocoyam output (leaves) (kg)** | | | | |
| Mean | 334.9 | 372.1 | 345.6 | 325.8 |

| | | | | |
|---|---|---|---|---|
| Std. Dev. | 255.0 | 310.5 | 277.7 | 264.7 |
| CV (%) | 76.14 | 83.44 | 80.35 | 81.24 |

| | **Mono-croppers** | **Mixed croppers** |
|---|---|---|
| **Cocoyam farm size (hectares)** | | |
| Mean | 0.93 | 1.04 |
| Std. Dev. | 0.38 | 0.55 |
| CV (%) | 40.86 | 52.88 |
| **Cocoyam output (corms) (kg)** | | |
| Mean | 6549.1 | 6223.4 |
| Std. Dev. | 2107.2 | 2420.8 |
| CV (%) | 32.18 | 38.90 |
| **Cocoyam output (leaves) (kg)** | | |
| Mean | 407.9 | 775.9 |
| Std. Dev. | 263.49 | 323.96 |
| CV (%) | 64.60 | 41.75 |

| | **Corm yield (kg/ha)** | | | **Leaves yield (kg/ha)** | | |
|---|---|---|---|---|---|---|
| | **AAS** | **AN_D** | **F_D** | **AAS** | **AN_D** | **F_D** |
| Mean | 6033.1 | 6624.8 | 6873 | 881.2 | 483.3 | 411.4 |
| Std. Dev. | 1032.9 | 1185.2 | 1241.3 | 217.4 | 152.2 | 137.3 |
| CV (%) | 17.12 | 17.89 | 18.06 | 24.67 | 31.50 | 33.38 |
| | **Mono croppers** | **Mixed croppers** | | **Mono croppers** | **Mixed croppers** | |
| Mean | 7042 | 5984.7 | | 438.6 | 746.1 | |
| Std. Dev. | 1117.6 | 1218.5 | | 183.2 | 322.0 | |
| CV (%) | 15.87 | 20.36 | | 41.78 | 43.17 | |
| | **Overall mean yields** | | | | | |
| Mean | 6515.07 | | | 592.31 | | |
| Std. Dev. | 1213.1 | | | 253.4 | | |
| CV (%) | 18.62 | | | 32.79 | | |

*1 bag of corm = 80kg; 1 Bundle/roll of leaves = 0.35kg. N (Pooled) =150; N(AAS; AN_D; F_D) = 50

## APPENDIX II: Collinearity test and model results

### 1. Multicollinearity test with explanatory variables of the SPF model

| Model | | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| 1 | (Constant) lnqty_leaves_harv | | |
| | Lnlabour | .322 | 3.101 |
| | Lncorms | .510 | 1.960 |
| | Lnfrmsz | .543 | 1.843 |

| | | |
|---|---|---|
| Lnothercost | .499 | 2.006 |
| Chemusage | .736 | 1.359 |
| Cropsys | .525 | 1.904 |
| Gender | .814 | 1.228 |
| Lnextension | .628 | 1.591 |
| Lnage | .728 | 1.373 |
| Lnfarmexp | .547 | 1.829 |
| Lnhhsize | .279 | 3.583 |
| Lnoffinc | .544 | 1.838 |
| Lnfrmage | .850 | 1.176 |
| Lnvolunteer | .290 | 3.444 |
| Lneduc | .827 | 1.210 |
| location1 | .357 | 2.798 |
| location2 | .442 | 2.260 |
| | .362 | 2.760 |

## 2. Results from Cobb Douglas Production function POOLED DATASET STATA 12 output.

```
Stoc. frontier normal/exponential model                 Number of obs =       150
                                                        Wald chi2(19)  =   9169.34
Prob > chi2   =    0.0000
Log likelihood =   -21.4869
------------------------------------------------------------------------------------
lnoutput |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval] ------------
----------+------------------------------------------------------------------- Frontier
|              lnfrmsz |   .1740491   .0489903     3.55   0.000     .0780299
.2700683          lnothercosts |    .000834   .0001691     4.93   0.000     .0013059
.1801372              lnlabour |   .2076529   .0959404     2.15   0.031     .0186131
.3946926               lncorms |   .1014847   .0311862     3.29   0.001     .0414608
.1637086             chemusage |  -.1086855   .0654574    -1.65   0.100    -.2359796
.0206086              crop_sys |   .1385822   .0031423     2.45   0.040     .0063978
.2707666                gender |   .1417271   .0577292     2.46   0.014       .02858
.2548742 amnt_leaves_harvested |  -.0024481   .0004891    -5.01   0.001    -.0002607
-.000069           ext_contact |   .0192346   .0099138     1.94   0.052    -.0001961
.0386654                   age |   .0023294   .0026677     0.87   0.383    -.0028992
.007558               farm_exp |   .0145404   .0039799     3.65   0.000      .00674
.0223408             education |   .0332665   .0137167     2.50   0.012     .0073823
.0611507               hh_size |   .0196627   .0105321     1.87   0.062    -.0009799
.0403052        land_occupancy |   .0683397   .0560896     1.22   0.223    -.0415939
.1782734               farmage |  -.0120231   .0053193    -3.23   0.001    -.0193128
-.0047335            offfarminc |   .0001873   .0006431     0.14   0.892    -.0000117
.0000135  volunteer_proportion |   .0001325   .0010052     0.13   0.895    -.0018377
.0021027                 aas_d |  -.1257056   .0724572    -1.74   0.097    -.2592664
.0251526                  an_d |  -.0113427   .7264632     0.01   0.987    -.2553624
.1600477                 _cons |   5.472573   .4255927    12.79   0.000     4.608427
6.27672
----------------------+-------------------------------------------------------------
Usigma                |
               _cons |  -9.600917   22.71928    -0.42   0.673    -54.12989    34.92805
----------------------+-------------------------------------------------------------
Vsigma                |
               _cons |  -2.552275    .117054   -21.80   0.000    -2.781697   -2.322854
----------------------+-------------------------------------------------------------
sigma_u |     .008226   .0934441      0.09   0.930     1.76e-12    3.84e+07      sigma_v
|    .2791133   .0163357    17.09   0.000      .2488641    .3130392        sigma2 |
.0779763   .0090355                       .060267    .0956856        lambda |   .6184718
.0853868     7.27    0.000     -.1614029    .2203465 -------------------------------------
------------------------------------------ Likelihood-ratio test of sigma_u=0:
chibar2(01) = 0.00    Prob>=chibar2 = 1.000
```

**Results from Cobb Douglas production function – STATA 12 output**

**3. Results from Translog Production function –POOLED DATASET STATA 12 output**

```
Stoc. frontier normal/exponential model            Number of obs =        150
                                                   Wald chi2(26)  =   1878.46

Prob > chi2   =    0.0000
Log likelihood =   -16.0638
------------------------------------------------------------------------------
lnoutput |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval] ------------
----------+------------------------------------------------------------- Frontier
|              lnfrmsz |   2.343036   .8752844     2.66   0.005    -4.140922
4.774515          lnothercosts |  -2.344711   .8752617    -2.68   0.004    -.0425096
-.0048325              lnlabour |   .0892396   1.152863     0.08   0.880    -1.962432
2.478311               lncorms |   .114084   .0586716     1.93   0.082    -.9284519
1.33222             lnlabour2 |  -.1323101   .2435048    -0.54   0.621    -.546275
.3780629              lncorms2 |   .1284403   .0573445     2.24   0.046    -.0876528
.1371333              lnfrmsz2 |  -.2892641   .1381808    -2.09   0.035    -.5756536
-.0496747         lnothercosts2 |  -.0996707   .1344113    -0.74   0.414    -.0425086
-.0048328          lncorm_lnlab |   .0231739   .0123948     1.87   0.070    -.2153041
.8821563        lncorm_lnfrmsz |   .1139904   .0581404    19.01   0.000     .0115573
.2394635     lncorm_lnothcosts |  -.0228256   .6423276    -0.04   0.917    -.1561257
.0646745         lnlab_lnfrmsz |   .3135536   .1741829     1.80   0.072    -.0278386
.6549458        lnlab_lnothcost |    .13560     .13748      0.99   0.377    -.0982775
.2103776      infrmsz_lnothcost |   .1159137   .0489913     2.37   0.021     .0156891
.3225852              chemusage |  -.1485404   .0627468    -2.34   0.021    -.2637378
-.019343               crop_sys |   .1221443   .0709841     1.71   0.088    -.0179819
.2602705                 gender |   .1380531   .0572307     2.42   0.021      .032843
.2532632 amnt_leaves_harvested |  -.0013042   .0004906    -3.25   0.001    -.0002315
-.0000369           ext_contact |   .0152431    .009946     1.43   0.152    -.0052508
.0337369                    age |   .0026801   .0025748     1.50   0.168    -.0023664
.0077266               farm_exp |   .0137245   .0039193     3.50   0.000     .0060429
.0214061              education |  -.0278876   .0232271     2.35   0.025    -.061963
.0538122                hh_size |   .0136144   .0101243     1.35   0.163    -.0042288
.0354576         land_occupancy |   .0254494   .0572232     0.43   0.683    -.080706
.1436047               farmage |  -.0108185   .0035434    -3.05   0.002    -.0177633
-.0038736             offfarminc |   .0004362   .0006540     0.67   0.523    -.0000126
.0000129  volunteer_proportion |  -.0020486   .0139708    -0.07   0.942    -.0019733
.0018322                  aas_d |  -.0464677   .8117948    -0.05   0.971    -.2138626
.0989273                   an_d |  -.0457414   .0843862     0.54   0.517    -.127979
.2028088                  _cons |   6.180111   3.112425     1.99   0.064    -.5489291
11.76915
----------------------+-----------------------------------------------------------------
Usigma                |
               _cons |  -9.741531   24.11918    -0.40   0.686    -57.01425    37.53119
----------------------+-----------------------------------------------------------------
Vsigma                |
               _cons |  -2.681359   .1173012   -22.86   0.000    -2.911265   -2.451453
----------------------+-----------------------------------------------------------------
sigma_u |    .0076675   .0924668     0.08    0.934      4.16e-13     1.41e+08      sigma_v
|   .2616678    .015347    17.05   0.000     .2332528    .2935444       sigma2 |
.081526   .0079403                        .0529632    .0840888       lambda |   .6723024
.0892878     7.55   0.000    -.1594182     .218023 -----------------------------------
------------------------------------------ Likelihood-ratio test of sigma_u=0:
chibar2(01) = 0.00   Prob>=chibar2 = 1.000
```

## 4. AAS_D DATASET

```
Stoc. frontier normal/exponential model            Number of obs =         50
                                                   Wald chi2(17)  =    884.79
Prob > chi2   =    0.0000
Log likelihood =    -25.8262
-------------------------------------------------------------------------------------
lnoutput |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval] ------------
----------+---------------------------------------------------------------- Frontier
|              lnfrmsz |    .149223    .072244     2.06   0.025    -.0428004
.2572464         lnothercosts |   -.050276   .1964442    -2.56   0.019    -.1903146
.0387826             lnlabour |   .6152904   .1920495     3.20   0.001    -.2557055
.5462863              lncorms |   .4551786   .0891297     5.11   0.000     .4802483
.9041089            chemusage |   -.136239   .0728716    -1.87   0.068    -.2214447
.0759666             crop_sys |   .1096706   .2944102     0.37   0.665    -.0067712
.2261124               gender |  -.0970176   .0710608     1.37   0.195    -.0805792
.1666144 amnt_leaves_harvested |   .0024154   .0000633    40.17   0.000    -6.80e-06
.0002899          ext_contact |   .0381548   .0138141     2.71   0.003     .0249995
.0713101                  age |   .0032605   .0024066     1.33   0.218    -.0024565
.0069774             farm_exp |   .0031412   .0017061     1.82   0.059    -.0057498
.0100323            education |   .0054143   .0043493     1.22   0.386    -.0370436
.057615               hh_size |   .0051557   .0152606     0.34   0.680    -.041446
.0683746        land_occupancy |   .0051634   .0612078     0.08   0.882    -.1509684
.3046415              farmage |  -.0051826   .0609134    -0.08   0.880    -.0125128
.0067475            offfarminc |   .0001462   .0007346     0.19   0.794     -.000116
.0002292  volunteer_proportion |   -.000426   .0009808    -0.44   0.610    -.0031783
.0006664                 _cons |   4.852113   .8331818     5.76   0.000     1.707226
4.887001
----------------------+--------------------------------------------------------------
Usigma                |
                _cons |  -10.83355   32.44842    -0.33   0.738    -74.43128    52.76417
----------------------+--------------------------------------------------------------
Vsigma                |
                _cons |  -3.779179   .2019484   -18.71   0.000    -4.174991   -3.383368
----------------------+--------------------------------------------------------------
sigma_u |    .0044414   .0720589     0.06   0.951     6.88e-17    2.87e+11     sigma_v
|    .1511338   .0152606      9.90   0.000     .1239973     .1842091        sigma2 |
.0704888   .0045861                     .0138603    .0318373       lambda |   .6423875
.0195784      3.37   0.000    -.1187435    .1775185 -----------------------------------
------------------------------------------   Likelihood-ratio   test   of   sigma_u=0:
chibar2(01) = 0.00   Prob>=chibar2 = 1.000
```

**Results from Cobb Douglas production function – STATA 12 output**

**Results from Cobb Douglas production function – STATA 12 output**

**5. AN_D DATASET**

```
Stoc. frontier normal/half-normal model          Number of obs   =         50
                                                 Wald chi2(17)   =     601.33
Log likelihood =   -20.5124                      Prob > chi2     =    0.0000
------------------------------------------------------------------------------------
lnoutput |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval] ------------
----------+-----------------------------------------------------------------
lnfrmsz |  .1450037   .0590513    2.46   0.029   -.1170022   .1027149        lnothercosts
|  -.5031016   .1962108      2.57   0.010    -.2090542    .3652574              lnlabour
|   .2593257   .1229812      2.11   0.027    -.1572969    .4273544               lncorms
|   .6880415   .0094191      7.55   0.000     .0074755     .193355             chemusage
|  -.2011251   .1002089     -2.01   0.032    -1.147463   -.7350513              crop_sys
|   .1424605   .0381535      2.74   0.000     .1080784    .8471225                gender
|   .2208037   .1250642     -1.77   0.075    -.4420654     .805058 amnt_leaves_harvested
|  -.0021571   .0006303     -3.33   0.000    -.0003535   -.0000779           ext_contact
|   .0749305   .0326012      2.34   0.040     .0391528    .1199082                   age
|   .0178515   .0164369      1.06   0.212     .0032153    .0264876              farm_exp
|   .0228563   .0068426      3.19   0.001      .008445    .0352675             education
|   .0391874   .0186085      0.21   0.806     .0146235    .0883514               hh_size
|   .0509243   .0164112      3.19   0.002     .0257189    .0861297        land_occupancy
|   .1304729   .1041665      1.25   0.173    -.0160182    .3589639               farmage
|  -.0180357   .0060642     -3.01   0.000     -.031416   -.0092997            offfarminc
|   .0002172   9.90e-05     -2.02   0.031    -.0000449   -8.43e-06  volunteer_proportion
|   .00084001     .00158      0.53   0.576    -.0016966    .0044969                 _cons
|    6.30325   1.029104      6.18   0.000     3.977283    8.493218
----------------------+-------------------------------------------------------------
             /lnsig2v |  -3.582481   .9849987    -3.64   0.000    -5.513043   -1.651919
             /lnsig2u |  -6.777338   64.00756    -0.11   0.916    -132.2298    118.6752 ----
------------------+---------------------------------------------------------------
sigma_v |   .1667532   .0821258                      .0635123    .4378147
sigma_u |   .0337536   1.080242                      1.93e-29    5.89e+25
sigma2  |   .0729459   .0077038                      -.063248    .1211398
lambda  |   .6902414   0.051597                     -2.070563    2.475396 -------------------
--------------------------------------------------------------------
Likelihood-ratio test of sigma_u=0: chibar2(01) = 0.00   Prob>=chibar2 = 1.000
```

**Results from Cobb Douglas production function – STATA 12 output**



**6. F_D DATASET**

```
Stoc. frontier normal/half-normal model           Number of obs   =        50
                                                  Wald chi2(17)   =    630.37
Log likelihood =   -28.3482                        Prob > chi2     =    0.0000
---------------------------------------------------------------------------------------
lnoutput |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval] ------------
----------+------------------------------------------------------------------
lnfrmsz |  .1270655  .0563451    2.28  0.039   -.5159563   .5268862       lnothercosts
|   .0780628   .1460945     0.53   0.625    -.4737659    .6810231              lnlabour
|   .2417946   .1105299     2.18   0.022    -.5510082   1.524597                lncorms
|   .9551807   .2473569     3.87   0.000    -.6976113   1.135225              chemusage
|  -.2408401   .1052097     2.30   0.029    -.6730516    .3227318              crop_sys
|   .1784033   .0671029     2.65   0.009    -.0385564    .8305029                gender
|   .2190783   .1142286     1.92   0.051     .1851789   1.032387 amnt_leaves_harvested
|    .002844   .0025128     1.12   0.241    -.0004642    .0005203           ext_contact
|   .0223532   .0756474     2.86   0.002    -.0701208    .1696143                   age
|   .0150768   .0060909     2.48   0.023    -.0194249    .0275786              farm_exp
|   .0224183   .0071075     3.14   0.000    -.0422045    .1193679             education
|   .0513511   .0193893     2.68   0.007    -.1015495    .0313294               hh_size
|   .0564445   .0151884     3.73   0.000    -.1215564    .4320594         land_occupancy
|   .1242706   .0992049     1.25   0.122    -.2491638     .559705               farmage
|  -.2027156   .0061468     3.33   0.000     -.099076    .0485071             offfarminc
|   .0022004   .0074307     3.14   0.000    -.0000411      .00013   volunteer_proportion
|   .0015077   .0016636     0.75   0.487    -.0092184    .0090627                  _cons
|   6.235499   1.152037     5.41   0.000    -4.482534    11.34213
----------------------+-----------------------------------------------------------------
             /lnsig2v |  -1.696274   .2409705    -7.04   0.000    -2.168568   -1.223981
             /lnsig2u |  -10.47942   902.1651    -0.01   0.991    -1778.691    1757.732 ----
-----------------+-------------------------------------------------------------------
sigma_v |    .4282119   .0515932                       .3381439    .5422705
sigma_u |    .0053018   2.391548                              0           .
sigma2 |   .0783393   .0051569                        .0929277    .2738594
lambda |   .7023812   .1102783                      -4.696988     4.72175 --------------------
--------------------------------------------------------------------
Likelihood-ratio test of sigma_u=0: chibar2(01) = 0.00   Prob>=chibar2 = 1.000
```

**APPENDIX III: Detailed cost structure of cocoyam production**

**1. Cost structure of cocoyam production (hectare) for cocoyam producers (pooled)**

| Item/Activity | Unit | Quantity | Unit price (GH¢) | Total (GH¢) |
|---|---|---|---|---|
| **Variable costs** | | | | |
| Labour costs | | | | |
| Vegetation clearing & land preparation | Man day | 22 | 15 | 330 |
| Carting of corms | Man day | 6 | 11 | 66 |
| Sett preparation and planting | Man day | 22 | 15 | 330 |
| Weeding (3x) | Man day | 33 | 15 | 495 |
| Spraying | Man day | 4 | 15 | 60 |
| Fertilization | Man day | 3 | 11 | 33 |
| Harvesting | Man day | 27 | 15 | 405 |
| Gathering/heaping | Man day | 11 | 9 | 99 |
| Total labour cost | | | | 1818 |
| Cocoyam setts | Kg | 830 | 0.293 | 243 |
| Fertilizer | 50 kg | 3 | 87 | 261 |
| Herbicides | Litres | 6 | 18 | 108 |
| Marketing costs | | | | |
| Loading and offloading | Lump sum | | | 57 |
| Carriage/transportation | Lump sum | | | 488 |
| Market tolls/tickets | Lump sum | | | 52 |
| Total marketing cost | | | | 597 |
| **Total variable cost** | | | | **3027** |
| **Fixed costs** | | | | |
| Land rent | Hectare | 1 | 180 | 180 |
| Cutlass | Number | 2 | 18.8 | 37.7 |
| Sacks | Number | 17 | 2 | 34 |
| Baskets | Number | 5 | 13.2 | 55 |

**Results from Cobb Douglas production function – STATA 12 output**

| | | | | |
|---|---|---|---|---|
| Depreciation **(computed using 3 years economic life for each asset below)** | | | | |
| Hoe | Number | 2 | 5 | 10 |
| Spraying machine | Number | 1 | 16.7 | 23.3 |
| **Total fixed cost** | | | | **340** |
| **Total production cost** | | | | **3367** |

Source: Field Survey (2015)

**2. Cost structure of cocoyam production (hectare) in producers in Asante Akyem South District**

| Item/Activity | Unit | Quantity | Unit price (GH¢) | Total (GH¢) |
|---|---|---|---|---|
| **Variable costs** | | | | |
| Labour costs | | | | |
| Vegetation clearing & land preparation | Man day | 22 | 15 | 330 |
| Carting of corms | Man day | 7 | 12 | 84 |
| Sett preparation and planting | Man day | 22 | 15 | 330 |
| Weeding (3x) | Man day | 30 | 15 | 450 |
| Spraying | Man day | 4 | 15 | 60 |
| Fertilization | Man day | 3 | 12 | 36 |
| Harvesting | Man day | 27 | 15 | 405 |
| Gathering/heaping | Man day | 10 | 12 | 120 |
| Total labour cost | | | | 1825 |
| Cocoyam setts | Kg | 613 | 0.343 | 210 |
| Fertilizer | 50 kg | 3 | 71.3 | 213.9 |
| Herbicides | Litres | 6 | 17.9 | 107.4 |
| Marketing costs | | | | |
| Loading and offloading | Lump sum | | | 51 |
| Carriage/transportation | Lump sum | | | 306 |
| Market tolls/tickets | Lump sum | | | 49 |
| Total marketing cost | | | | 406 |
| **Total variable cost** | | | | **2752** |
| **Fixed costs** | | | | |
| Land rent | Hectare | 1 | 207 | 207 |
| Cutlass | Number | 2 | 22 | 44 |
| Sacks | Number | 18 | 1.4 | 25.2 |
| Baskets/pans | Number | 5 | 13.2 | 66 |
| Depreciation **(computed using 3 years economic life for each asset below)** | | | | |
| Hoe | Number | 2 | 4.8 | 9.6 |
| Spraying machine | Number | 1 | 16.7 | 16.7 |
| **Total fixed cost** | | | | **368** |
| **Total production cost** | | | | **3120** |

Source: Field Survey (2015)

3. **Cost structure of cocoyam production (hectare) in producers in Asunafo North District**

| Item/Activity | Unit | Quantity | Unit price (GH¢) | Total (GH¢) |
|---|---|---|---|---|
| **Variable costs** | | | | |
| Labour costs | | | | |
| Vegetation clearing & land preparation | Man day | 22 | 15 | 330 |
| Carting of corms | Man day | 7 | 10 | 70 |
| Sett preparation and planting | Man day | 24 | 15 | 360 |
| Weeding (3x) | Man day | 33 | 15 | 495 |
| Spraying | Man day | 3 | 15 | 45 |
| Fertilization | Man day | 3 | 10 | 30 |
| Harvesting | Man day | 25 | 15 | 375 |
| Gathering/heaping | Man day | 12 | 10 | 120 |
| Total labour cost | | | | 1825 |
| Cocoyam setts | Kg | 1087 | 0.276 | 300 |
| Fertilizer | 50 kg | 4.5 | 78.8 | 354.6 |
| Herbicides | Litres | 7 | 20.3 | 142.1 |
| Marketing costs | | | | |
| Loading and offloading | Lump sum | | | 64 |
| Carriage/transportation | Lump sum | | | 274 |
| Market tolls/tickets | Lump sum | | | 50 |
| Total marketing cost | | | | 388 |
| **Total variable cost** | | | | **3010** |
| **Fixed costs** | | | | |
| Land rent | Hectare | 1 | 225 | 104 |
| Cutlass | Number | 2 | 19 | 38 |
| Sacks | Number | 12 | 2.5 | 30 |
| Baskets/pans | Number | 5 | 10 | 50 |
| Depreciation **(computed using 3 years economic life for each asset below)** | | | | |
| Hoe | Number | 2 | 4 | 8 |
| Spraying machine | Number | 1 | 23.3 | 23.3 |
| **Total fixed cost** | | | | **253** |
| **Total production cost** | | | | **3263** |

Source: Field Survey (2015)

4. **Cost structure of cocoyam production (hectare) in producers in Fanteakwa District**

| Item/Activity | Unit | Quantity | Unit price (GH¢) | Total (GH¢) |
|---|---|---|---|---|
| **Variable costs** | | | | |
| Labour costs | | | | |
| Vegetation clearing & land preparation | Man day | 22 | 15 | 330 |
| Carting of corms | Man day | 5 | 10 | 50 |
| Sett preparation and planting | Man day | 20 | 15 | 300 |
| Weeding (3x) | Man day | 35 | 15 | 525 |
| Spraying | Man day | 4 | 15 | 60 |
| Fertilization | Man day | 3 | 12 | 36 |
| Harvesting | Man day | 29 | 15 | 435 |
| Gathering/heaping | Man day | 12 | 6 | 76 |
| Total labour cost | | | | 1812 |
| Cocoyam setts | Kg | 889 | 0.281 | 250 |
| Fertilizer | 50 kg | 2.3 | 82 | 188.6 |
| Herbicides | Litres | 6 | 16.8 | 100.8 |
| Marketing costs | | | | |
| Loading and offloading | Lump sum | | | 61 |
| Carriage/transportation | Lump sum | | | 826 |
| Market tolls/tickets | Lump sum | | | 60 |
| Total marketing cost | | | | 947 |
| **Total variable cost** | | | | **3299** |
| **Fixed costs** | | | | |
| Land rent | Hectare | 1 | 225 | 255 |
| Cutlass | Number | 2 | 18.5 | 37 |
| Sacks | Number | 20 | 2.5 | 40.8 |
| Baskets | Number | 5 | 11.5 | 57.5 |
| Depreciation **(computed using 3 years economic life for each asset below)** | | | | |
| Hoe | Number | 2 | 6.34 | 12.8 |

| | | | | |
|---|---|---|---|---|
| Spraying machine | Number | 1 | 20.67 | 26.3 |
| **Total fixed cost** | | | | **399** |
| **Total production cost** | | | | **3698** |

Source: Field Survey (2015)



5. **Cost structure of cocoyam production (hectare) in producers practises monocropping**

| Item/Activity | Unit | Quantity | Unit price (GH¢) | Total (GH¢) |
|---|---|---|---|---|
| **Variable costs** | | | | |
| Labour costs | | | | |
| Vegetation clearing & land preparation | Man day | 22 | 15 | 330 |
| Carting of corms | Man day | 6 | 10 | 60 |
| Sett preparation and planting | Man day | 20 | 15 | 300 |
| Weeding (3x) | Man day | 35 | 15 | 525 |
| Spraying | Man day | 4 | 15 | 60 |
| Fertilization | Man day | 3 | 10 | 30 |
| Harvesting | Man day | 29 | 15 | 435 |
| Gathering/heaping | Man day | 11 | 10 | 110 |
| Total labour cost | | | | 1850 |
| Cocoyam setts | Kg | 956 | 0.314 | 300 |
| Fertilizer | 50 kg | 2.5 | 81 | 203 |
| Herbicides | Litres | 5 | 15.4 | 77 |
| Marketing costs | | | | |
| Loading and offloading | Lump sum | | | 102 |
| Carriage/transportation | Lump sum | | | 560 |
| Market tolls/tickets | Lump sum | | | 60 |
| Total marketing cost | | | | 722 |
| **Total variable cost** | | | | **3152** |
| **Fixed costs** | | | | |
| Land rent | Hectare | 1 | 158 | 158 |
| Cutlass | Number | 2 | 16 | 32 |
| Sacks | Number | 20 | 1.8 | 36 |

| | | | | |
|---|---|---|---|---|
| Baskets | Number | 6 | 10 | 60 |
| Depreciation **(computed using 3 years economic life for each asset below)** | | | | |
| Hoe | Number | 2 | 5 | 10 |
| Spraying machine | Number | 1 | 20.67 | 20.67 |
| **Total fixed cost** | | | | **317** |
| **Total production cost** | | | | **3469** |

Source: Field Survey (2015)

6. **Cost structure of cocoyam production (hectare) in producers practises mixedcropping**

| Item/Activity | Unit | Quantity | Unit price (GH¢) | Total (GH¢) |
|---|---|---|---|---|
| **Variable costs** | | | | |
| Labour costs | | | | |
| Vegetation clearing & land preparation | Man day | 20 | 15 | 330 |
| Carting of corms | Man day | 6 | 12 | 70 |
| Sett preparation and planting | Man day | 23 | 15 | 345 |
| Weeding (3x) | Man day | 30 | 15 | 450 |
| Spraying | Man day | 4 | 15 | 75 |
| Fertilization | Man day | 3 | 12 | 36 |
| Harvesting | Man day | 22 | 15 | 330 |
| Gathering/heaping | Man day | 10 | 9 | 90 |
| Total labour cost | | | | 1726 |
| Cocoyam setts | Kg | 760 | 0.296 | 225 |
| Fertilizer | 50 kg | 5 | 81 | 405 |
| Herbicides | Litres | 7 | 16 | 112 |
| Marketing costs | | | | |
| Loading and offloading | Lump sum | | | 55 |
| Carriage/transportation | Lump sum | | | 475 |
| Market tolls/tickets | Lump sum | | | 50 |
| Total marketing cost | | | | 582 |
| **Total variable cost** | | | | **3001** |
| **Fixed costs** | | | | |

| | | | | |
|---|---|---|---|---|
| Land rent | Hectare | 1 | 232 | 202 |
| Cutlass | Number | 2 | 18 | 36 |
| Sacks | Number | 14 | 2 | 28 |
| Baskets | Number | 4 | 11 | 44 |
| Depreciation **(computed using 3 years economic life for each asset below)** | | | | |
| Hoe | Number | 2 | 5 | 10 |
| Spraying machine | Number | 1 | 23.7 | 23.7 |
| **Total fixed cost** | | | | **344** |
| **Total production cost** | | | | **3345** |

Source: Field Survey (2015)

## APPENDIX IV Constraints of cocoyam production

### 1. Constraints facing cocoyam producers in Asante Akyem South

| Constraint statement | Strongly agree (5) | Agree (4) | Neutral (3) | Disagree (2) | Strongly disagree (1) | Mean score (rank) |
|---|---|---|---|---|---|---|
| **Production related** | | | | | | |
| High labour intensity | 8 (16) | 10 (20) | 29 (58) | 3 (6) | 0 (0) | 4.5 [1] |
| High cost of labour | 34 (68) | 6 (12) | 7 (14) | 1 (2) | 2 (4) | 4.1 [2] |
| High incidence of weeds | 21 (42) | 15 (30) | 1 (2) | 7 (14) | 6 (12) | 3.8 [3] |
| Access to cultivable land | 10 (20) | 17 (34) | 1 (2) | 5 (10) | 17 (34) | 3.7 [4] |
| Labour scarcity | 9 (18) | 12 (24) | 25 (50) | 3 (6) | 1 (2) | 2.7 [5] |
| Low soil fertility | 5 (10) | 6 (12) | 8 (16) | 23 (46) | 8 (16) | 2.3 [6] |
| Category mean | | | | | | 3.52 |
| **Socio-economic related** | | | | | | |
| High interest rate on available credit | 24 (48) | 3 (6) | 11 (22) | 2 (4) | 10 (20) | 4.6 [1] |
| High perishability of leaves | 43 (86) | 1 (2) | 2 (4) | 4 (8) | 0 (0) | 4.3 [2] |

| | | | | | | |
|---|---|---|---|---|---|---|
| Inadequate capital to invest | 27 (54) | 13 (26) | 3 (6) | 1 (2) | 6 (12) | 4.1 [3] |
| Limited access to credit | 21 (42) | 16 (32) | 4 (8) | 3 (6) | 6 (12) | 3.7 [4] |
| Category mean | | | | | | 4.18 |
| **Marketing related** | | | | | | |
| High cost of transport to market | 30 (60) | 7 (14) | 5 (10) | 5 (10) | 3 (6) | 4.4 [1] |
| Unpredictability of produce price | 14 (28) | 25 (50) | 6 (12) | 3 (6) | 2 (4) | 4.4 [1] |
| Poor road infrastructure | 30 (60) | 13 (26) | 1 (2) | 3 (6) | 2 (6) | 4.2 [3] |
| Low prices in accessible markets | 9 (18) | 24 (48) | 8 (16) | 5 (10) | 4 (8) | 3.6 [4] |
| Category mean | | | | | | 4.15 |
| Overall Constraint Score | | | | | | 3.89 |
| Krippendorff's Alpha (Kα) | **0.51** | | LL95%CI=0.523 | | UL95%CI=0.585 | |

**2. Constraints facing cocoyam producers in Asunafo North District**

| **Constraint statement** | **Strongly agree (5)** | **Agree (4)** | **Neutral (3)** | **Disagree (2)** | **Strongly disagree (1)** | **Mean score (rank)** |
|---|---|---|---|---|---|---|
| **Production related** | | | | | | |
| High incidence of weeds | 36 (72) | 8 (16) | 4 (8) | 2 (4) | 0 (0) | 4.6 [1] |
| High cost of labour | 34 (68) | 6 (12) | 7 (14) | 1 (2) | 2 (4) | 4.4 [2] |
| Access to cultivable land | 30 (60) | 9 (18) | 1 (2) | 5 (10) | 5 (10) | 4.1 [3] |
| Labour scarcity | 9 (18) | 12 (24) | 25 (50) | 3 (6) | 1 (2) | 3.5 [4] |
| High labour intensity | 8 (16) | 10 (20) | 29 (58) | 3 (6) | 0 (0) | 3.5 [4] |
| Low soil fertility | 5 (10) | 6 (12) | 8 (16) | 23 (46) | 8 (16) | 2.5 [5] |
| Category mean | | | | | | 3.77 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Socio-economic related** | | | | | | |
| High perishability of leaves | 43 (86) | 1 (2) | 2 (4) | 4 (8) | 0 (0) | 4.7 [1] |
| High interest rate on available credit | 35 (70) | 11 (22) | 2 (4) | 2 (4) | 0 (0) | 4.6 [2] |
| Limited access to credit | 34 (68) | 5 (10) | 8 (16) | 2 (4) | 1 (2) | 4.4 [3] |
| Inadequate capital to invest | 33 (66) | 7 (14) | 1 (2) | 7 (14) | 2 (4) | 4.2 [4] |
| Category mean | | | | | | 4.48 |
| **Marketing related** | | | | | | |
| Unpredictability of produce price | 14 (28) | 25 (50) | 6 (12) | 3 (6) | 2 (4) | 4.7 [1] |
| Poor road infrastructure | 30 (60) | 13 (26) | 1 (2) | 3 (6) | 3 (6) | 4.3 [2] |
| High cost of transport to market | 30 (60) | 7 (14) | 5 (10) | 5 (10) | 3 (6) | 4.1 [3] |
| Low prices in accessible markets | 9 (18) | 24 (48) | 8 (16) | 5 (10) | 4 (8) | 3.6 [4] |
| Category mean | | | | | | 4.18 |
| Overall Constraint Score | | | | | | 4.09 |
| Krippendorff's Alpha (Kα) | **0.62** | | LL95%CI=0.448 | | UL95%CI=0.688 | |

**3. Constraints facing cocoyam producers in Fanteakwa**

| Constraint statement | Strongly agree (5) | Agree (4) | Neutral (3) | Disagree (2) | Strongly disagree (1) | Mean score (rank) |
|---|---|---|---|---|---|---|
| **Production related** | | | | | | |
| High cost of labour | 27 (54) | 16 (32) | 3 (6) | 3 (6) | 1 (2) | 4.3 [1] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| High incidence of weeds | 14 (28) | 26 (52) | 5 (10) | 3 (6) | 2 (4) | 4.0 | 2 |
| Access to cultivable land | 28 (56) | 8 (16) | 2 (4) | 5 (10) | 7 (14) | 3.9 | 3 |
| High labour intensity | 16 (32) | 10 (20) | 16 (32) | 5 (10) | 3 (6) | 3.6 | 4 |
| Labour scarcity | 15 (30) | 12 (24) | 8 (16) | 9 (18) | 6 (12) | 3.4 | 5 |
| Low soil fertility | 3 (6) | 25 (50) | 5 (10) | 7 (14) | 10 (20) | 3.1 | 6 |
| Category mean | | | | | | 3.72 | |
| **Socio-economic related** | | | | | | | |
| Inadequate capital to invest | 36 (72) | 9 (18) | 0 (0) | 2 (4) | 3 (6) | 4.5 | 1 |
| High interest rate on available credit | 31 (62) | 12 (24) | 6 (12) | 0 (0) | 1 (2) | 4.4 | 2 |
| Limited access to credit | 37 (74) | 5 (10) | 1 (2) | 4 (8) | 3 (6) | 4.3 | 3 |
| High perishability of leaves | 32 (64) | 7 (14) | 8 (16) | 2 (4) | 1 (2) | 4.3 | 3 |
| Category mean | | | | | | 4.38 | |
| **Marketing related** | | | | | | | |
| Low prices in accessible markets | 28 (56) | 13 (26) | 5 (10) | 3 (6) | 1 (2) | 4.3 | 1 |
| Unpredictability of produce price | 13 (26) | 32 (64) | 4 (8) | 0 (0) | 1 (2) | 4.1 | 2 |
| Poor road infrastructure | 25 (50) | 3 (6) | 6 (12) | 13 (26) | 3 (6) | 3.7 | 3 |
| High cost of transport to market | 14 (28) | 7 (14) | 10 (20) | 4 (8) | 15 (30) | 3.0 | 4 |
| Category mean | | | | | | 3.78 | |
| Overall Constraint Score | | | | | | 3.92 | |
| Krippendorff's Alpha (Kα) | **0.44** | | LL95%CI=0.362 | | UL95%CI=0.427 | | |

## APPENDIX V: Study Questionnaire

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**FACULTY OF AGRICULTURE**

**Department of Agricultural Economics, Agribusiness and Extension *Economic Analysis of Cocoyam Production in Ghana.***

| **Introduction** |
| --- |
| I would like to invite you to participate in a detailed research study in cocoyam production as part of a project on value addition and new food product development from roots and tubers. This survey therefore seeks to know more about the cocoyam production systems, benefits or returns from the production and their production constraints in order to propose pragmatic solutions to addressing such constraints. I kindly request that you cooperate to complete the following short questions. It should take no longer than 45 minutes of your time.<br>***Your response is of uttermost importance to us.***<br><br>**Thank you.**<br><br>**Preface** |

a. **Name of enumerator: _______________________________________________**

b. **Date of interview: ________/_______/2015**

c. **Time interview started: ______:_________** **Time ended: _____:______**

d. **Region: 1. Ashanti [ ] 2. Brong Ahafo [ ] 3. Eastern [ ]**

e. **District: 1. Asante Akyem South [ ] 2. Asunafo North [ ] 3. Fanteakwa [ ]**

f. **Name of Community: _____________________________________________**

**Part I: Demographic Characteristics of Farmers**

1. Name of Respondent: ___________________________________________ ***(not compulsory)***
2. Telephone/Contact: _________________________
3. Sex of respondent: 1. Male [ ] 0. Female [ ]
4. Age of respondent: ________________years
5. Age of respondent (category): 1. Less than 20 [ ] 2. 20-30 [ ] 3. 31-40 [ ] 4. 41-50 [ ] 5. Above 50 [ ]
6. Level of education: 1. None [ ] 2. Non-formal/Basic [ ] 3. Secondary/pre-tertiary [ ] 4. Tertiary [ ]
7. Actual number of years in formal education: ___________years
8. Household size: ____________
9. Gender of household head: 1. Male [ ] 0. Female [ ]
10. Religion: 1. Christianity [ ] 2. Islam [ ] 3. Traditionalist [ ] 4. Other [ ] specify: __________________
11. Ethnic affiliation: 1. Akan [ ] 2. Bono [ ] 3. Ga [ ] 4. Krobo [ ] 5. Ewe [ ] 6. Northerner [ ] 7. Other [ ]
12. Marital status: 1. Married [ ] 2. Single [ ] 3. Widowed [ ] 4. Divorced/Separated [ ]
13. Main occupation**:** 1. Farming [ ] 2. Salary worker [ ] 2. Artisan/Vocational [ ] 4. Trading/Commerce [ ] 5. Other: __________________
14. Secondary occupation: 1. Farming [ ] 2. Salary worker [ ] 2. Artisan/Vocational [ ] 4. Trading/Commerce [ ] 5. Other: ________________________

**Part II: Background Information on Cocoyam Production**

15. Years in farming**:** __________years.
16. Years in cocoyam farming**:** ____________years.
17. What is the main objective for cultivating cocoyam? 1. Only for household food [ ] 2. Mainly for food, sell surplus [ ] 3. Equally for food and sale [ ] 4. Mainly for sale [ ] 5. Others [ ] Specify: ______________________

**Part III: Production issues**

**18.** Land occupancy/ownership status: 1. Own land [ ] 2. Family land [ ] 3. Rented land [ ]

4. Sharecropping [ ] 5. Others [ ] specify: _________________

**19.** Total agricultural land owned by the household: _______________ (acres)



**20.** Farm size information:

| | **2014** | **2013** | **2012** |
|---|---|---|---|
| **a**. Total farm size for all crops (acres) | | | |
| **b**. Number of farm fields with cocoyam | | | |
| **c**. Farm size for the largest cocoyam farm (acres) | | | |
| **d.** Farm size of cocoyam field 2 (acres) | | | |
| **e.** Farm size of cocoyam field 3 (acres) | | | |

**21.** Please indicate the various proportions (using percentages) of volunteer cocoyam against planted cocoyam on the **cocoyam farms.**

| **Proportion of volunteer cocoyam to planted cocoyam.** | | | | | | |
|---|---|---|---|---|---|---|
| | **Largest cocoyam farm (%)** | | **Cocoyam Farm 2 (%)** | | **Cocoyam Farm 3 (%)** | |
| | **Planted** | **Volunteer** | **Planted** | **Volunteer** | **Planted** | **Volunteer** |
| **2014** | | | | | | |
| **2013** | | | | | | |
| **2012** | | | | | | |

**22.** Time of planting: 1. Major season [ ] 2. Minor season [ ]

***NB: All proceeding questions should be based on the main/largest cocoyam farm for last season (2014).***

**23.** For how long have you been continuously cultivating on this land? _______________years

**24.** For how long have you continuously cultivated **cocoyam** on this land? _____________years

**25.** What cropping system is practiced on the biggest cocoyam farm during the last cropping season?

1. Mono [ ] 2. Mixed [ ]

**26.** If mixed (2), what are the major crops on largest cocoyam farm and their respective proportions of land allotted for each crop?

| Main crops on largest cocoyam farm | a. [Tick all that apply] | b. Proportion (%) on farmland planted to crop |
|---|---|---|
| a. Cocoyam | [ ] | |
| b. Plantain | [ ] | |
| c. Cocoa | [ ] | |
| d. Cassava | [ ] | |
| e. Vegetables | [ ] | |
| f. Oil Palm | [ ] | |
| g. Others1: | [ ] | |
| h. Others2: | [ ] | |

**27.** How far is the cocoyam farm from your homestead (in miles): ___________________

**28.** How long does it for you to reach your farm? ________________minutes.

**29.** Is your farm land connected/nearer to a motorable road? 1. Yes [ ] 0. No [ ]

**30.** What is the **main** target produce for cultivating cocoyam: 1. Cormels [ ] 2. Leaves [ ] 3. Both [ ]

**31.** Do you know of any improved cocoyam variety? 1. Yes [ ] 0. No [ ]

**32.** If yes, please mention the variety: _________________________________________

**33.** Did you **plant** any improved cocoyam variety last year? 1. Yes [ ] 2. No [ ]

**34.** If yes, please mention the variety: _________________________________________

**35.** What is the **main** sources of planting material **(tick all that apply)**? 1. Own farm [ ] 2. Friends/relatives [ ] 3. MoFA [ ] 4. Other farmers [ ] 5. Others [ ] specify: ______________________________

**36.** If not from own farm (1), did you buy? 1. Yes [ ] 0. No [ ]

**37.** **If yes**, how much was spent on acquiring the planting material during the last cropping system? GHc ________

**38.** Was your cocoyam farm affected by any diseases? 1. Yes [ ] 0. No [ ]

**39.** If yes, which diseases **(tick all that apply)**? 1. Root rot/decay [ ] 2. Leaf blight [ ] 3. Leaf spot [ ] 4. Other [ ] specify: _______________________

**40.** Did you treat the disease? 1. Yes [ ] 0. No [ ]

**41.** **If yes**, mode of treatment: 1. Spraying with agrochemicals [ ] 2. Uprooting and throwing away infected plant [ ] 3. Burying of infected plant [ ] 4. Others [ ] specify: ________________________________________________

**42.** Was your cocoyam farm affected by any pests? 1. Yes [ ] 0. No [ ]

**43.** If yes, which pests **(tick all that apply)**? 1. Rodents [ ] 2. Birds [ ] 3. Millipedes [ ] 4. Caterpillar [ ] 4. Others [ ] specify: ____________

**44.** Did you control the pests? 1. Yes [ ] 0. No [ ]

**45.** If yes, mode of treatment: 1. Spraying with agrochemicals [ ] 2. Physical control [ ] 4. Setting of traps [ ] 3. Others [ ] specify: ____________

**46. Please provide information on typical months in which cocoyam are planted and harvested last season** (**please tick all that apply**)

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Major months in which cocoyam is planted | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** |
| Major months in which cocoyam is harvested | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** |

**47.** How much did it cost for a 120kg of cormels for the **peak periods** of last season (2014): GHc _____________

**48.** How much did it cost for the same 120kg of cormels during the **slack periods** of last season: GHc __________

**49.** How often do you pluck cocoyam leaves for consumption in a week? _____________ (times)

**50.** How often do you pluck cocoyam leaves to sell in a month? ________________ (times)

**51.** How many months after planting cocoyam do you start harvesting of leaves for either consumption or sale? _______________ (months)

**Part IV: Outputs, Costs and Returns associated with cocoyam production in 2014 cropping season.**

**52.** To whom did you sell **most** of your cormels? 1. Direct consumers [ ] 2. Middlemen [ ] 3. Aggregators/collectors [ ] 4. Retailers [ ] 5. Wholesalers

**53.** To whom did you sell **most** of your cocoyam leaves? 1. Direct consumers [ ] 2. Middlemen [ ] 3. Aggregators/collectors [ ] 4. Retailers [ ] 5. Wholesalers [ ] 6. Others____________________

**54.** How long does it normally take to harvest your matured cormels for sale after planting? _________ (months)

**55.** How often in a month do you harvest your cormels for sale after it has matured? ______________times

**56.** Why do you harvest it in such pattern? 1. Harvested based on demand [ ] 2. Harvested during market days [ ] 3. No reason [ ] 4. Others: ____________________________________

**57. Please provide the following information on output, prices and revenues of your production on an acre of cocoyam farm.**

| **Revenue/sales obtained from cocoyam farm** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Commodity** | **a. Farm size (acres)** | **b. Qty planting materials (80kg bag)** | **c. Unit price per bag of planting materials** | **c. Total Output *per 80 kg bag for corms **per bundles/rolls for leaves** | **d. Quantity sold *per 80kg bags for corm **per bundles/rolls for leaves** | **e. Price per unit (GH¢)** | **f. Total Revenue from sales (GH¢) (g=d*e)** |
| Cormels | | | | | | | |
| Leaves | | | | | | | |

**58. Costs associated with production per acre of cocoyam farm for 2014 cropping season**

| **Activity** | **Quantity (see units below the table)** | | | **d. Unit of measurement** | **e. Unit cost (GH¢)** | **f. Total cost (GH¢) (f=c*e)** | **g. Activity Performed mainly by (see below for codes)** |
|---|---|---|---|---|---|---|---|
| | **a. HH labour** | **b. Hired labour** | **c. Total (c=a+b)** | | | | |
| Clearing of vegetation (logging, burning, stumping etc.) | | | | | | | |
| Land Preparation (slashing, ploughing, harrowing etc.) | | | | | | | |
| Carting of corms | | | | | | | |
| Planting | | | | | | | |
| 1st Weeding | | | | | | | |
| 2nd Weeding | | | | | | | |
| 3rd Weeding | | | | | | | |
| Weedicides/herbicides | | | | | | | |
| Application of weedicides/herbicides | | | | | | | |
| Fertilizer | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Application of fertilizer | | | | | | | |
| Harvesting | | | | | | | |
| Gathering and heaping | | | | | | | |
| Carriage of farm produce **(to house and/or market)** | | | | | | | |
| Loading | | | | | | | |
| Offloading | | | | | | | |
| Market toll/ticket | | | | | | | |
| Other expenses1: | | | | | | | |
| Other expenses2: | | | | | | | |
| **c. Other costs/assets (fixed)** | **Number used** | | **Unit cost (GH¢)** | **Economic Life (years)** | | | |
| Cutlass | | | | | | | |
| Hoes | | | | | | | |
| Bag/sack | | | | | | | |
| Basket/pan | | | | | | | |
| Rent on land ***per annum*** | | | | | | | |
| Knapsack sprayer | | | | | | | |
| Value of land per acre | | | | | | | |
| Other: ………………… | | | | | | | |
| Other: ………………… | | | | | | | |

***Column d codes. 1. Mandays 2. Kilograms 3. Litres 4. Truckload 5. Others; specify……………………..***
***Column g codes 1. Male Adult 2. Female Adult 3. Both 1 and 2 4. Children 5. Hired Labour***

**59.** Please state categorically if there were any specific activities that were performed because of the cocoyam on the farm?

1. Yes [ ] 0. No [ ]

**60.** If yes please indicate such activities below by ticking below,

| Land Clearing | Land Preparation | Planting | 1st Weeding | 2nd Weeding | 3rd Weeding | Agrochemicals Application |
|---|---|---|---|---|---|---|
| [ ] | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |

| Fertilizer Application | Harvesting | Gathering and Heaping | Carriage of Farm Produce | Market toll/ticket | Other1 | Other2 |
|---|---|---|---|---|---|---|
| **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** | **[ ]** |

**Part V: Other factors of Production.**

**61.** If agrochemicals were applied, did you buy? 1. Yes [ ] 0. No [ ]

**62. Please provide the information on Agro-Inputs employed during production. .**

| **Type of AgroInput** | **a. Name of the agroinput (if known)** | **b. Source of input (see codes below)** | **c. Main Location (see codes below)** | **d. Training on Input Usage 1. Yes 0. No** | **e. Service Providers (see codes below)** |
|---|---|---|---|---|---|
| Herbicides | 1 | | | | |
| | 2 | | | | |
| | 3 | | | | |
| Pesticides | 1 | | | | |
| | 2 | | | | |
| | 3 | | | | |
| Fertilizer | 1 | | | | |
| | 2 | | | | |
| | 3 | | | | |

***Column b codes 1. Wholesaler 2. Retailer 3. MoFA/Government 4. NGO's 5. Others: specify………………..***

***Column c codes 1. Within Community 2. Nearest town 3. District capital 4. Outside district 5. Other: specify Column e codes 1. MoFA; 2. NGOs 3. Input dealers 4. Other: specify***

**63.** What is the main source of capital for cocoyam production? 1. Own funds [ ] 2. Friends/relatives [ ] 3. Financial institutions [ ] 4. Middlemen/Traders [ ] 5. Moneylenders [ ] 6. Others [ ] specify: _______________

**64.** Did you obtain any credit or borrowed funds for cocoyam production activities during the 2014 cropping season? 1. Yes [ ] 0. No [ ]

**65.** If yes (1), from where? 1. Friends/relatives [ ] 2. Financial institutions [ ] 3. Informal Susu Schemes [ ] 4. Middlemen/Traders [ ] 5. Moneylenders [ ] 6. Others [ ] specify :

_____________________

**66.** Do you have an account with a bank or any financial institution? 1. Yes [ ] 0. No [ ]

**67.** Number of years of owning an account if yes (1): __________________

**68.** Were you able to save some money you made from the last cropping season? 1. Yes [ ] 0. No [ ]

**69.** How much were you able to save from cocoyam revenue during the last cropping season?

GH¢ ____________

**70.** Do you get extension visits? 1. Yes [ ] 0. No [ ]

**71.** Do you get extension visits or services for cocoyam cultivation specifically? 1. Yes [ ] 0. No [ ]

**72.** If yes, how many times in a year? _________________

**73.** Major point of sale: 1. Local Market [ ] 2. District Market [ ] 3. Farmgate [ ]

4. Outside district [ ] 5. Other [ ] specify: __________________

**74.** What is the distance from homestead to market?______________ miles

**75.** What is the **commonest** mode by which farmer gets produce clients? 1. Regular trade (informal contracts) [ ] 2. Spot trade [ ] 3. Contractural agreements [ ] 3. Other [ ] specify:

____________

**76.** What is the mode of transportation if sold in market? 1. By foot [ ] 2. By a tricycle [ ]

3. Truck **(Kia, etc.)** [ ]

**77.** If by tricycle or truck who owns it? 1. Owned by farmer [ ] 2. Owned by another farmer [ ]

3. Hired from transporters [ ] 4. Others [ ] specify: _________________________________

**78.** Do you usually get cocoyam market information before sale? 1. Yes [ ] 0. No [ ]

**79.** If yes, how do you get your market information? 1. Radio [ ] 2. Friends/fellow farmers [ ]

3. Traders [ ] 4. MoFA [ ] 5. Others [ ] specify: _______________________________

**80.** At what time interval do you receive market information? 1. Daily [ ] 2. Bi-weekly [ ]

2. Weekly [ ] 3. Monthly [ ] 4. Others [ ] specify:

**81.** Do you belong to any farmer's associations? 1. Yes [ ] 0. No [ ] (if no, skip to )

**82.** If yes, name of the producer's association you belong to

______________________________________________________________________________

**83.** How long have you been a member of this association? ____________years

**84.** Do you often store harvested cormels before sale? 1. Yes [ ] 0. No [ ]

**85.** How long do you **normally** store cormels before sale? _______________months

**86.** In what materials do you store cormels? 1. Fertilizer bags [ ] 2. Basket [ ] 3. No container [ ]

4. basin/bowl/pans [ ] 5. Poly-bags [ ] 6. Other [ ] specify______________________

**87.** Where do you store your harvested cormels? 1. Storeroom [ ] 2. Kitchen [ ] 3. Bedroom [ ] 4. Veranda [ ] 5. Dug out pits [ ]

**88.** Do you add any value to your cocoyam before sale by sorting or grading after harvesting?

1. Yes [ ] 2. No [ ]

**89.** If yes (1), please indicate the type of value added to your cocoyam and its associated cost

| **Activity performed** | **Value Addition 1=Yes 2=No** | **Total Cost Incurred (GH¢)** |
|---|---|---|
| Cleaning | [ ] | |
| Storage | [ ] | |
| Grading/sorting | [ ] | |
| Packaging | [ ] | |
| Other 1_______________________ | [ ] | |
| Other 2_______________________ | [ ] | |
| Other 3_______________________ | [ ] | |

**90.** If you do some grading and sorting, on what basis you do grade? 1. Sizes [ ] 2. Appearance [ ] 3. Variety [ ] 4. Age [ ] 5. Others [ ] specify: _________________________________

**Part VIII: Household Income Sources**

**91.** Indicate sources of income and their proportions to the total household income for the 2014 cropping season.

| **Income source** | **a. Amount (GH¢)** | **b. Proportion to HH income (%)** |
|---|---|---|
| Sales from cocoyam | | |
| Sales from other crops | | |
| Sales from cash crops | | |
| Sales from farm animals | | |
| Salaries/pensions | | |
| Remittances | | |
| Casual labour (farmhand) | | |
| Trading | | |
| Other non-farm sources | | |
| **TOTAL** | | |

**Part VI: Constraints of Production, Storage and Marketing**

**92.** Please provide by **ticking appropriately for each constraint**, the degree of severity of the constraints below.

| **Constraint** | ***Please provide responses ranging from*** **1=Strongly disagree………… 5=Strongly disagree** |
|---|---|
| Lack of improved cultivars/planting materials | |
| Limited credit access | |
| Inadequate capital to invest | |
| High interest rate on credit | |
| Inadequate access to agro-inputs | |
| Limited access to suitable land | |
| High incidence of weeds | |
| Unavailability of planting materials | |
| High cost of planting material | |
| Erratic rainfall pattern | |
| High cost of fertilizer | |
| Limited access extension service | |
| High diseases and pests prevalence in the farm | |
| Low soil fertility | |
| High labour intensity | |
| Scarcity of labour | |
| High cost of labour | |
| Poor road infrastructure (transportation problems) | |
| High occurrence of rot and decay during storage | |
| Price fluctuations in produce | |
| High perishability of leaves | |
| Low market prices of cormels and leaves | |
| Low demand for the crop | |
| Lack of ready market | |
| High cost of transportation | |
| Poor storage facilities | |
| Far distance to market centres | |
| Others1: | |
| Others2: | |