# PRODUCTION EFFICIENCY AMONG SMALLHOLDER ARABICA COFFEE FARMERS IN BUHIGWE AND KIGOMA DISTRICTS, TANZANIA



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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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## ABSTRACT

Coffee is one of the most important export commodities in Buhigwe and Kigoma districts. Unfortunately, production is still low and information on technical efficiency has remained a scarce. This study sets out to contribute to the efforts of improving coffee productivity to enhance cash income of smallholder Arabica coffee farmers in Buhigwe and Kigoma districts, Tanzania. To achieve its objective, the present study estimates the Technical Efficiency (TE) and inefficiency effects using single stage Maximum Likelihood Estimation. Additionally, it uses gross margin to determine profitability whereas descriptive statistics to assess contribution of coffee production to household cash income and challenges facing smallholder coffee farmers in various economic activities. The results show that the mean TE index is 68% and number of coffee trees and farming experience being the key factors affecting TE. Moreover, the results show that, coffee production is profitable with the mean gross margin of TZS 730/tree and contributes about 39% of total household cash income. Input prices, taxes and other deductions, shortage of extension services, unreliable markets and low coffee price, low quality of coffee, transportation and delayed payment delay are significantly reported by respondents as challenges face coffee production. The present study farmers are technically inefficient and there is a 32% scope for increasing TE. Number of coffee trees, experience and education level are the management levels that influence TE. Coffee production is profitable and contributes to household income and hence useful in reducing poverty. The study recommends deliberate education on farm expansion and engaging youth in production to improve TE. Interventions on supply of new coffee varieties, prices, taxes, extension services, quality, transport and delayed payment delay and economic activities diversifications are crucial to enhance farmers` income

## DECLARATION

I, Rogers Andrew, do hereby declare to the Senate of Sokoine University of Agriculture, that this dissertation is my original work done within the period of registration and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

24/11/2013

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Above declaration is confirmed

25/11/2013

Damas Philip (PhD) Date

(Supervisor)

## COPYRIGHT

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# DEDICATION

I dedicate this achievement to my wife Eliselina Stephano and my mother Elizabeth Gwalama for their sincere love and commitment.

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AE | Allocative Efficiency |
| AERC | African Economic Research Consortium |
| BACAS | Bureau for Agricultural Consultancy and Advisory Services |
| EU | European Union |
| CAN | Calcium Ammonium Nitrate |
| CBD | Coffee Berry Disease |
| CLR | Coffee Leaf Rust |
| COLS | Corrected Ordinary Least Squares |
| CPU | Central Pulpery Unit |
| DAP | Di Ammonium Phosphate |
| DEA | Data Envelopment Analysis |
| DALDO | District Agricultural and Livestock Development Officer |
| FAO | Food and Agriculture Organization |
| FOB | Free on Board |
| GM | Gross Margin |
| HP | Home Processed |
| IMF | International Monetary Fund |
| KANYOVU | Kalinzi-Manyovu Union |
| LR | Likelihood-Ratio |
| ML | Maximum Likelihood |
| MLE | Maximum Likelihood Estimates |
| NBS | National Bureau of Statistics |
| NGO | Non Governmental Organization |
| PhD | Doctor of Philosophy |
| QIG | Quality Improvement Gain |

| | |
|---|---|
| SFA | Stochastic Frontier Analysis |
| SHI | Sustainable Harvest International |
| SAPs | Structural Adjustment Programs |
| SUA | Sokoine University of Agriculture |
| TaCRI | Tanzania Coffee Research Institute |
| TCB | Tanzania Coffee Board |
| TE | Technical Efficiency |
| TZS | Tanzania Shillings |
| UK | United Kingdom |
| URT | United Republic of Tanzania |
| US$ | United State Dollar |
| USAID | United State of Agency for International Development |
| VAT | Value Added Tax |
| VMP | Value Marginal Product |

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background

Coffee is a major source of income for millions of smallholder farmers worldwide and is a significant source of export earnings to many nations including Tanzania. Coffee is one of Tanzania's primary export crops representing about 5% of total export, 24% of traditional crops and generating exporting earning averages US$ 100 million per annum over the last 30 years (TCB, 2011). The coffee industry provides direct income to more than 400 000 farm families and also benefits indirectly the livelihoods of 2.4 million Tanzanians. Arabica coffee covers about 80% of the approximately 200 000 hectare of land under coffee production and represents 70% of output (URT, 2008). The major arabica coffee growing regions are Arusha, Kilimanjaro, Mbeya and Ruvuma Robusta is mainly produced in the Kagera region. Other arabica coffee growing regions include Kigoma, Iringa, Tanga, Morogoro, Manyara, Rukwa, Mwanza and Mara. Robusta coffee is only produced in Kagera region (TCB, 2011).

Tanzania is endowed with abundant suitable land with appropriate altitude, temperature, rainfall and soil suitable for growing several crops. The country's export crops include coffee, cotton, cashew nut, tobacco, sisal, pyrethrum, tea, cloves, horticultural crops, oil seeds, spices and flowers. The major staples produced in the country include maize, sorghum, millet, rice, wheat, pulses (mainly beans), cassava, potatoes and bananas (UTR, 2011).

According to TCB (2011), arabica coffee actual yield in Tanzania is estimated to be 200-300 kg/ha while robusta is 750 kg/ha. According to Mwakalobo (1997), potential yield of arabica coffee is about 1 250kg/ha while Panyatona and Nopchinwong (2005) contend that potential yield of robusta coffee yield is 1500kg/ha. The difference in yield for the two varieties is because of the genetic nature whereby a robusta variety is robust in producing beans.

The ultimate objective of the government of Tanzania is to increase productivity in existing agricultural activities through agricultural transformation that focuses on investing in more productive technologies (URT, 2008). Although the government`s objective about coffee production is well stipulated, yet the current performance of coffee sector is not inspiring. According to International Coffee Partner (2011), coffee sector in Tanzania today is characterized by extremely low yields (with only 0.25kg per tree of green coffee; the yields are among the lowest in the world), poor maintenance of coffee fields and poor quality. USAID (2010) contends that, economic viability of coffee sector in Tanzania is hampered by unaffordable inputs, threats posed by Coffee Berry Disease (CBD) and Coffee Leaf Rust (CLR).

In creating better environment for coffee producers and the country at large, Tanzanian government undertook a series of major marketing reforms. According Mdoe *et al.* (2002), before market liberalization, inefficient agricultural marketing system was observed to be a major drawback in the development of agricultural sector. These reforms included decontrol of marketing of non-traditional export crops in 1986, which was followed by decontrol of marketing of food crops in 1989 and finally decontrol of marketing of traditional export crops in 1993/1994. Decontrol of agricultural marketing was meant to pave the way for the participation of private marketing agents (producers, traders, processors and exporters) along with the cooperatives in the marketing aspects of all agricultural crops in a competitive marketing environment that could bring about competitive prices at all levels of the marketing channel (URT, 2008). During the 1980s and 1990s, many developing countries including Tanzania adopted Structural Adjustment Programs (SAPs). These reforms were based mostly on the guidelines of international financial institutions such as; the International Monetary Fund (IMF) and the World Bank. The SAPs came as a response to the worsening economic situation in most developing countries during the 1970s and early 1980s. One important objective of SAPs was to prune the central government budget by restructuring several public enterprises. This goal was to be achieved through several measures including: liberalization of agricultural sector by allowing private enterprises to engage in agricultural production and marketing activities, and restructuring marketing boards and cooperative unions to improve their efficiency (TCB, 2008). Liberalization was expected to increase the profitability of cash crops by introducing multiple marketing channels and allowing farmers to receive a higher share of the proceeds from export sales. However, due to production going down; the high prices did not translate into higher income earnings to farmers (Ponte, 2002).

### 1.2 Statement of the problem and Justification

Albeit the pivotal role played by coffee in the economy of Tanzania, yield has been on a downward trend. According to TaCRI (2011), since the mid-1990s the Tanzanian coffee industry has been in a state of stagnation or decline. Winter-Nelson and Temu (2002) argue that low productivity in smallholder farms remains one of the major challenges to be overcome if coffee is to remain a viable farm enterprise. Despite the fact that coffee is the main cash agricultural commodity of Buhigwe and Kigoma districts, yield per hectare is still low. According to URT (2011), an average coffee yield is 151kg/ha, which is lower than national yield average which ranges between 200 and 250kg/ha. TaCRI (2009), contends that inefficient use of inputs such as inorganic fertilizers, unavailability of improved coffee varieties, pests and diseases, insufficient support such as extension services have been the root causes of low productivity.

Low coffee yield in Kigoma amongst other factors has made the region to have the lowest per capita income compared to other coffee producing regions. The survey done by BACAS (2005) shows that yield per hectare in Arusha, Kilimanjaro, Ruvuma, Mbeya and Karega were: 330, 433, 937 and 667 respectively. According to URT (2008), per capita income (TZS) in 2005 for coffee producing regions were: Kigoma, Arusha, Kilimanjaro, Ruvuma, and Kagera were: 206 359; 355 952; 375 873; 372 028; 354 023 and 226 773 respectively.

URT (2011) explains that coffee production in Kigoma is at a nascent stage involving about 4000 families. Also the area is constrained with poor application of agro-inputs, poor production technology, poor crop husbandry practices and transport infrastructure and marketing (URT, 2008). According to Mkondya (2009), allocation of production resources is determined by the given set of ecological, social, managerial and technological option for a particular point of time. The region has an excellent quality potential (won the 2010 "Taste of Harvest award for East, South and sub- Saharan Africa") URT (2011). There is a need to explore why high quality coffee is produced in Kigoma yet few farmers are involved and less is produced unlike in other producing areas in the country.

Recent studies on efficiency analysis include Mkondya, (2009) on economic analysis of small scale coffee production in Mbozi district whereby farmers were 82% technically efficient and Mwakalobo, (1997) on resource productivity and allocation efficiency in smallholder coffee farmer in Rungwe district, Tanzania whereby farmers were 49.2%

technically efficient. However, little is known about coffee production efficiency in the Kigoma and Buhigwe districts. Conducting the study in Kigoma and Buhigwe districts is important to understand the existing potential.

This study is in line with Agricultural and Livestock Policy, 1997:3.3.1 (b)(ix): Strengthening of information and documentation services, information management and technology, publications and dissemination of research information and networking in information services with external internal and external institutions, including national extension services. It is expected that the findings of this study will provide information that will enable policy makers to formulate and/or modify policies to help coffee farmers to increase yields and reduce income poverty among them. More so, high productivity will enable farmers and the country at large to take advantage of high quality coffee produced in area.

## 1.3 Research Objectives

### 1.3.1 Overall objective

The Overall objective of this study is to contribute to the efforts of improving coffee productivity so as to enhance income of smallholder arabica coffee farmers and hence help to reduce income poverty among them.

### 1.3.2 Specific objectives

This study pursued the following specific objectives:

i. To determine technical efficiency among coffee farmers in Kigoma and Buhigwe districts.

ii. To investigate factors influencing technical efficiency among smallholder coffee farmers in the study area.

iii. To determine the contribution of coffee production to household income.

iv. To assess challenges facing smallholder coffee farmers in various economic activities.

## 1.4 Hypotheses

i. Smallholder coffee farmers in Kigoma and Buhigwe districts are not technically efficient.

ii. Socio-economic factors do not significantly influence the farmers' technical efficiency.

## 1.5 Organization of the Study

The present study is organized into five main chapters. The first Chapter offers background of the study, statement of the problem and justification, objectives and hypotheses. The second Chapter consists of literature related to coffee production efficiency, theoretical and analytical frameworks. The third Chapter provides a description of the research methodology to highlight the location and characteristics of the study area, study design, conceptual framework, data collection, data analysis and limitation of the data collection. Chapter Four presents the empirical results and discussion of the research findings. The dissertation ends with Chapter Five that includes the main conclusion and recommendations.

# CHAPTER TWO

## 2.0 REVIEW OF LITERATURE

## 2.1 Definition of Concepts

### 2.1.1 Coffee plant

Coffee plant belongs to the botanical genus *Coffea* in the Rubiaceae family. The Rubiaceae family has approximately 500 genera and 6 000 species; 25-100 species belong to *Coffea*. The commercial green coffees are C. arabica and C. canephora, which are commercially referred to as Arabica and Robusta. Arabica coffee is the only type of coffee grown in Kigoma region. Production system is dominated by traditional coffee although in past few years TaCRI introduced new varieties. In 2007 a total of 25 000 coffee seedlings were raised from seed, of which 6 000 seedlings were raised by farmers and 19 000 by TaCRI in Mwayaya station. Also a micro-drip irrigation system was installed at the station mother garden to improve production and productivity of the clonal nursery. According to TCB (2011), farmers in Kigoma region are in initial stage of adopting the seedlings that have been raised by TaCRI.

### 2.1.2 Production trend for arabica coffee in Tanzania

Coffee production level in Kigoma has not been steadily growing because of low yield per hectare and the few number of families engaged in the sector. Fig. 1 shows that coffee production in Kigoma Region has been fluctuating in the past twelve years. According to NBS (2012), the highest number of households growing coffee is found in Kagera (223 137) followed by Kilimanjaro (104 061), and Mbeya (79 175), Ruvuma (37 005), Arusha (15 736) and the lowest number was in Kigoma (11 035).

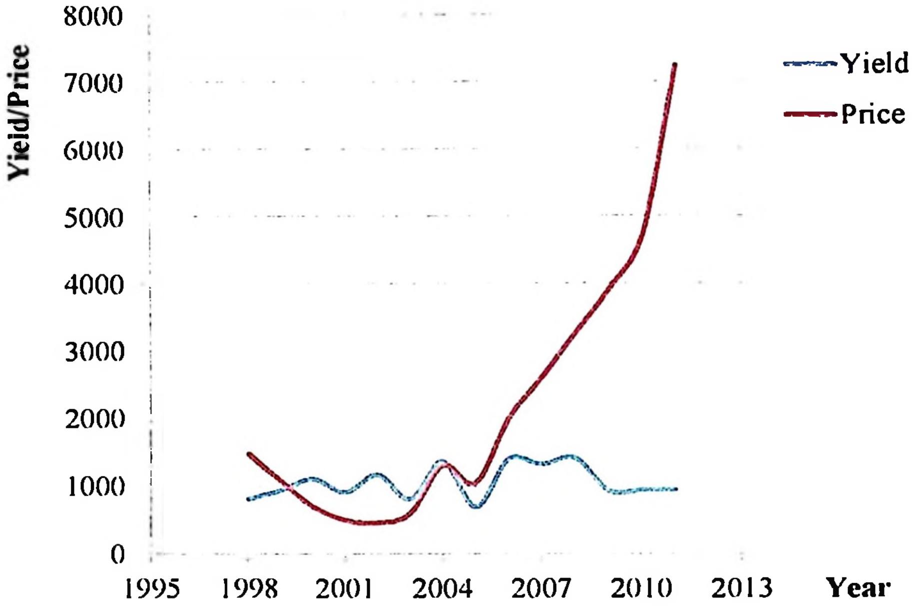


**Figure 1: Trend of coffee production and price in Kigoma (1998-2011)**

Source: Adapted from DALDO Kigoma District, 2011

Generally current coffee production level in Tanzania do not significantly differ from the average yearly production of 50 000 tons recorded over the past thirty years (1980-2010), (TCB, 2011). The main cause of low yield is the age of coffee tree as well as inefficiencies in husbandry practices and low inputs' productivity. According to Friedrich (2004), most of the coffee trees around Tanzania have exceeded the age of 20-25 years at which coffee tree is considered to be the most productive. A yield decline is exacerbated by poor farm maintenance practices and diseases. Fig. 2 shows that coffee production and export have not increased rather they have retrogressed as the highest peak was recorded in early 1971s.

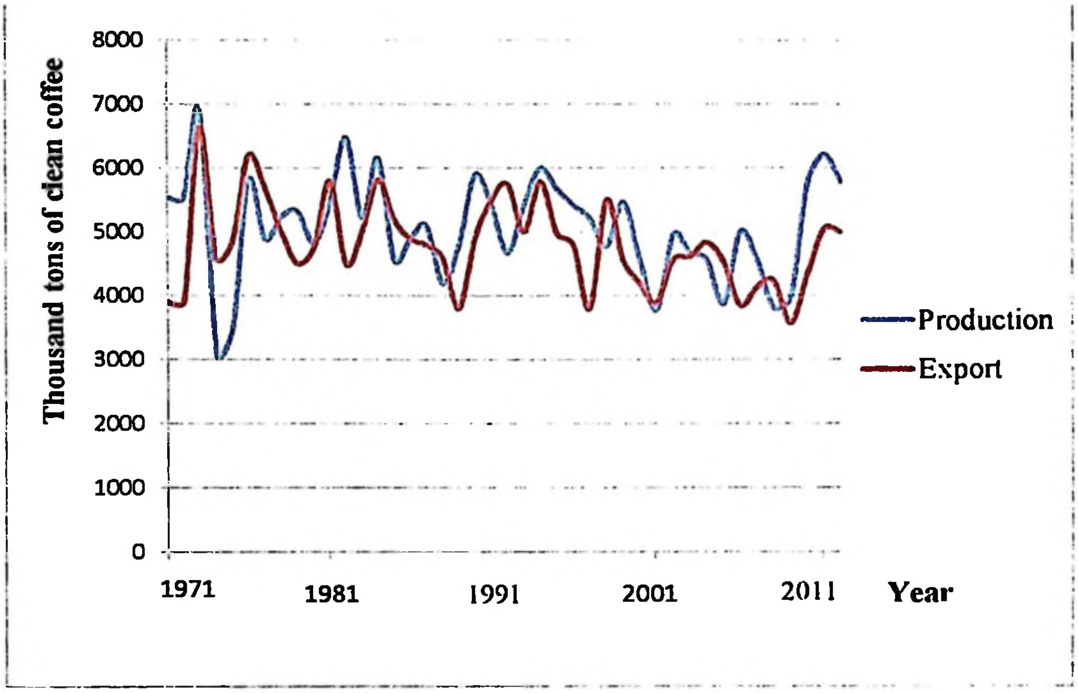


**Figure 2: Trend of coffee production and export in Tanzania (1971-2011)**

Source: Tanzania Coffee Board, 2011

### 2.1.3 Production efficiency

Technical Efficiency (TE) evaluates the farm's ability to obtain the maximum possible output from a given set of resources (Mwakalobo, 1997). Generally speaking, TE refers to the ability of a firm to minimize input use in the production of a given output vector or to obtain the maximum output from a given input vector (Philip, 2007). In economic analysis, efficiency can be divided into two components, *i.e.* TE and Allocative Efficiency (AE). AE refers to the ability of a firm to use inputs in optimal proportions, given their respective prices. The product of these two measures of efficiency (TE and AE) gives the overall economic efficiency. Production efficiency measures whether the economy is producing as much as possible without wasting precious resources and hence high level of productivity.

In the coffee sector where prices of both inputs and outputs are very volatile, TE is very important in policy recommendation compared to AE. By definition, AE is the ratio of value marginal product ($VMP_i$) to marginal cost ($P_{xi}$) of the $i^{th}$ input ($VMP_i$)/$P_x$. Hence, if $VMP_i > P_{xi}$; the input is considered underused and one may conclude that farm profit can be raised by increasing the usage of this input. Conversely, if $VMP_i < P_{xi}$; the input is considered overused and one can recommend to reduce input use so as to raise farm income. The point of AE (maximum profit) is reached when $VMP = P_{xi}$.

In addition, coffee marketing is affected by institutional factors like quality and export restrictions of which are not included in AE definition. Furthermore, provided that agrochemicals are available and affordable, their applications, for example, depend on prevalence of diseases and pests. High agrochemical use above maximum recommended levels, it imposes quality problem hence fetching lower prices. Therefore, this study focused on TE only.

### 2.1.4 Productivity

The highest productivity of any factor of production is attained when that factor is efficiently utilized. The terms, productivity and efficiency, are often used interchangeably, but they are not exactly the same (Coelli *et al.*, 2005). Given available technology, there is a feasible production set which entails all input-output combinations that are feasible. Producers can have a high total factor productivity levels because they are efficient and vice versa. As noted by Foster *et al.* (2007), low productivity plants are less likely to survive and thrive than their more efficient counterparts. Yuki (1999) explains that efficient farmers earn higher profit than traditional farmers due to their high yields. According to URT (2008), the average coffee yield in Kigoma region is 151kg/ha, which is lower than the national average yield which ranges from 200 to 250kg/ha. Land productivity in Tanzania is the lowest compared to Kenya and Uganda. Odhiambo *et al.* (2006) found that coffee productivity per hectare were 450kg, 1 200kg and 211kg in Uganda, Kenya and Tanzania respectively.

### 2.1.5 Coffee marketing

Coffee marketing starts at the farm gate and ends at the consumer level. In Kigoma and Buhigwe districts, there are several coffee marketing channels. According to URT (2008), primary coffee processing involves cherry sorting, pulping, fermentation, drying. Processing is done either at home (home processed) or the smallholder farmers deliver their cherry to co-operative CPUs for primary processing. Dry cherry is usually bulked at the farm and delivered to the factory for onward transport to the miller located at Matyazo village. By 2011, there were 13 coffee cooperative societies (Rumako. Kalinzi, Mahwenyi, Nyaruboza, Mbanga, Mkibanda, Mukigo, Manyovu, Nyakimue, Muhange, Kibwigwa, Muhinda and Mwese), which jointly form the apex union known as Kanyovu (TaCRI, 2011).

After primary processing, coffee is delivered by cooperative societies to the Kanyovu miller for secondary processing. Secondary processing involves hulling, grading and sorting of parchment coffee to produce clean (green) coffee before storage and sale. With coffee market liberalization in August 1993, farmers sell coffee through different market channels (BACAS, 2005). Some sell to private traders, other farmers and primary cooperatives. According to TCB (2011), about 97% of clean coffee produced in Kigoma and Buhigwe districts is sold through apex cooperative (Kanyovu). Farmers collect their coffee to Kanyovu and it is responsible to documentation on quality assessment, final weights and milling losses to the growers or their agents. Also Kanyovu cooperative is the only body responsible for contracting with buyers who wish to buy coffee while in

Kigoma as well as to coordinate with auctioneers in Moshi for coffee collected by primary cooperatives. After coffee is sold Kanyovu receives payments from the buyers. After deducting statutory deductions and taxes, Kanyovu is supposed to remit the rest of the money to the primary cooperatives and then primary cooperatives to farmers.

### 2.1.6 Farm gate price

In the production process, there is a direct linkage between levels of farm revenue, prices of a commodity and prices of inputs and real farm income. Survey by Cole (2011) shows that, some Tanzanian coffee farmers receive as low as 50% of the auction price for the coffee that they produce. TCB (2011) reported that coffee farmers receive farm gate coffee price which on average ranges between 65% and 70% of FOB coffee price. Coffee prices is largely determined by the international exchange markets in New York and London. It is difficult for producing countries with low world market share like Tanzania to influence world price (Kodama, 2009). There are five International coffee trading houses: Dreyfus (France), EDF/Mercon (UK), Esteve (Brazil), Neumann (Germany), and Volcafe' (Switzerland) (Diaz, 2009). The EU is the world's largest importer of coffee, accounting for 66% of worldwide imports or 4 million tons imported in 2008, followed by the United States of Ameica (1.5 million tons) and Japan (or 423 602 tons) (FAO, 2009). International coffee market situation contributes highly to lower coffee farm gate price. Basically coffee farmers face the interrelated pressures of rapid market liberalization, volatile and declining prices, higher input costs and low coffee quality, all these factors put them in a disadvantaged position in today's economy. Table 1 shows that the price of coffee in the study area was very low until 2006. The increase in price was because of intervention made by Sustainable Harvest International (SHI). In early 2007, SHI started working with 2 200 smallholder coffee farmers from cooperatives to help them reliably produce top quality coffee and sell it directly to the market (DALDO Kigoma District, 2011).

## 2.2 Theoretical Framework

This section presents the basic theory of production efficiency of coffee. Efficiency is crucial in production economics as it gives both economic theorists and economic policy makers' ideas about how well firms are performing in a relative sense. From productive efficiency, we can expect to know how much a firm/production unit can increase its output without using additional resources; thereby achieving an increase in efficiency (Foster *et al.*, 1957). Production efficiency entails optimization of resource use, appropriate resource and timely application. In TE efficiency analysis variable inputs are expected to influence statistically yield.

The research findings by Salazar (2006) on the use of organic fertilizers in coffee production in Guatemala, Honduras, Nicaragua and Vietnam found that, in Guatemala, Honduras and Nicaragua organic fertilizer had almost no impact on coffee yield while in Vietnam organic fertilizer had a positive correlation with coffee yield. The findings contradict themselves and except for Vietnam; the results were not in favour of organic coffee market.

Cardenas (2005) investigated efficiency of coffee production in Veracruz and Mexico and the result from the study found that smallholder coffee farmers were more technically efficient then estates. Conversely study by Ayoola (2012) on economic analysis of coffee production in Nigeria found that larger scale farmers were more technically efficient than small scale farmers and he argued that large scale farming is a business oriented activities whereby farmers spend much resources to earn profit. Cardenas *et al.* (2005) measured production efficiency of Mexican coffee-producing districts and they found that, households that had easier access to input and financial markets were technically efficient and they produced high quality coffee. More so, in his analysis he found that inorganic fertilizer was statistically contributing to productivity. In contrast, the study by Tran (2007) on the efficiency of coffee producers in Vietnam found that, TE score declined with the increase of fertilizer.

AERC (2007) on analysis of factors affecting the technical efficiency of arabica coffee producers in Cameroon, there was decreasing function of the farmers' educational level and the number of hours of instruction received by those farmers who participated in the extension service's modern technology project whereas farmers still using traditional production methods however, the level of education did not significantly affect technical efficiency of coffee production.

Basically, studies on technical efficiency have contradicting findings. In most cases, conclusions made by scholars do not consider optimal use of inputs in relation to TE. If a farmer has not researched optimal use of inputs, then TE strongly and statistically correlate with the input use and vice versa. In addition, researchers do not consider interactions between variables. Tran (2007) found that, relationship between TE and factor inputs became robust after adding the interaction variables in models. Lastly to come up with robust results in TE analysis, it is important to consider nature of the functional form to be used, type of data (cross-sectional, longitudinal or panel) and crop grown (annuals, bi-annual and perennials).

**2.3 Review of Analytical Approaches in Efficiency Analysis**

The efficiency of any firm can be measured directly using Stochastic Frontier Analysis (SFA) or Data Envelopment Analysis DEA). SFA requires different functional forms for its application unlike DEA. Cardenas (2004) put that, in order to construct the best practice frontier required to calculate various efficiency measures using either SFA or DEA.

### 2.3.1 Stochastic production function

Production frontier presents the maximum output attainable from each level of input. The firm operates on the frontier, if it is technically efficient or beneath the frontier if it is not efficient. Fig. 3 provides detailed description of technical efficiency in resources use. Point A represents an inefficient point whereas points B and C represent efficient points. Producers under utilize input x at point A. He/she could produce at C efficiently given the level of variable input x applied on fixed input.

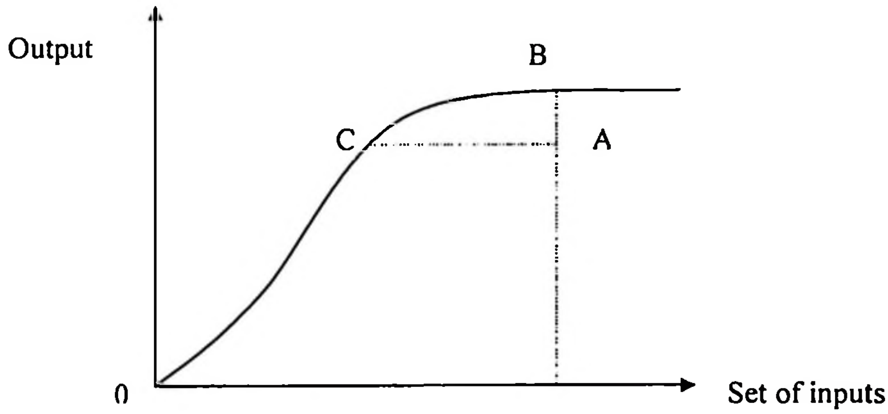


**Figure 3: Production frontier**

Source: Coelli *et al.* (2005)

The stochastic production frontier approach has been used to measure efficiency in different areas of agricultural economics. Greene (2005) explains that stochastic production proposed by Aigner *et al.* (1977) and Meeusen and van den Broeck (1977) is motivated by the idea that deviations from the production 'frontier' might not be entirely under the control of the firm being studied. Cardenas (2005) explains that the parametric approach uses classical econometric techniques in order to build production functions, which can be either deterministic or stochastic. A parametric model was first estimated by Aigner and Chu (1968). The stochastic frontier analysis developed by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977), has been used frequently in empirical works in the agriculture field (Kumbhakar, 1987).

Application of stochastic approach calls the use of different production functions. Coelli *et al.* (1998) mentioned common functions like linear, Cobb-Douglas, Quadratic, Normalized quadratic, Translog, Generalized Leontief and Constant Elasticity of Substitution that are useful in efficiency analysis. The appeal of the Cobb Douglas type of function rests largely with its simplicity. Taylor and Shonkwiler (1986) argue that as long as interests on efficiency measurement and not on analysis of the structure of the production technology, the Cobb-Douglass production function provides an adequate representation of the production technology. Appendix one summarizes results of a few empirical studies that applied production frontier.

### 2.3.2 Data Envelopment Analysis (DEA)

The DEA is a non-parametric approach that uses linear programming in order to construct a piecewise frontier. Philip (2007) elucidates that, the DEA is a linear programming technique developed in the work of Charnes *et al.* (1978). It is a non-parametric technique used in the estimation of production functions and has been used extensively to measure technical efficiency in a range of industries. Coelli *et al.* (2005) argues that, a key advantage of DEA, over other approaches of measuring efficiency, is that it can easily accommodate both multiple inputs and multiple outputs. Furthermore, unlike the Stochastic Frontier Analysis (SFA) approach, with DEA a specific functional form, for the production process, does not need to be imposed on the model (Philip, 2007). The next paragraph summarizes comparison between the two approaches hence deciding which approach useful in this study. In this respect SFA was selected for this study.

### 2.3.3 Comparison between SFA and DEA

Based on the nature of the study, where only one output is considered and is on agricultural production, it is very impossible to accommodate all variables in the model like weather, disease and pest variables in which case stochastic approach becomes superior to DEA. Stochastic production function is able to (1) accounts for measurement errors that could interfere in the process of shaping the frontier, (2) tests of hypotheses can be implemented, and (3) the stochastic frontier model can accommodate different assumptions about returns to scale. The stochastic frontier analysis is a parametric method that specifies a particular form of the error component in order to measure the producer inefficiency (Coelli *et al.*, 2005). According to Msuya *et al.* (2008), stochastic frontier is the technique better suit an agricultural production largely influenced by random exogenous shocks.

### 2.3.4 Gross margin analysis

Gross Margins (GM) are calculated to provide relative margins for all farmers in the production season (Izamuhaye, 2008). According to Ferris and Malcolm (2000), the gross margin analysis has the limitations such as: GM is not a profit figure since the fixed costs have to be covered by the gross margin before arriving at a profit figure. Ayoola (2012), small scale traditional farms have negligible fixed costs and so GM is a good approximation of net farm income. Different scholars have used the technique in profitability analysis to mention a few: Gabagambi (1998) used the GM in profitability analysis for smallholder production process in paddy and cotton production and Mutayoba (2005) used the technique in vanilla, coffee, tea, banana and maize to establish the relative economic profitability of various smallholders' in Bukoba district. GM was therefore used to estimate income from coffee production in the study area.

# CHAPTER THREE

## 3.0 METHODOLOGY

### 3.1 The Location of Study Area

This study was conducted in Buhigwe and Kigoma districts (Kigoma highland zone) which are located along Lake Tanganyika in western part of Tanzania. Kigoma and Buhigwe districts are located between latitudes 3.6 and 6.5 degrees South and longitudes 29.5 and 31.5 degrees east. To the North the Region borders Burundi and Kagera Region; it borders Shinyanga and Tabora to the east, Rukwa Region to the South and the Democratic Republic of Congo to the west (URT, 2008).

Coffee growing in Kigoma Region is concentrated in the wetter areas of the highland zone along Lake Tanganyika in the Northern part of the Region. Coffee production is concentrated in Manyovu and Kalinzi divisions in Buhigwe and Kigoma districts respectively. The Highlands zone has an altitude of between 1 500 and 1 700 meters above sea level with an annual rainfall of 1 300–1 650mm. Agriculture is the main economic activity in the area. Coffee, banana, beans, maize and cassava are the main crops grown in the study area (URT, 2008). The study areas were selected to provide information on production efficiency necessary in policy recommendation useful for actors in coffee sector make accurate decision about production.

### 3.2 Economic Activities

The economy of Kigoma and Buhigwe districts almost depends on agriculture and business. Basically crop production employs about 90% of the study area population (URT, 2008). The type of agriculture practised in the area is peasant agriculture whereby smallholders who employ very limited capital in their production process are the majority. Agricultural production in the study area is rain-fed.

There are two major main crops namely coffee and bananas. Maize, pigeon peas, beans and cassava are produced in Kigoma and Buhigwe districts. There is cross border trade on cereals with neighboring countries of Burundi, Democratic Republic of Congo and Rwanda. Other commercial crops include horticultural crops such as pineapples, passion fruits, tomatoes and cabbages. Food crops include cassava, maize, beans, bananas, vegetables, sweet potatoes and peas. Farm sizes vary from 0.5 hectare to 4 hectares per household. A few of households keep different animal species such as cattle, sheep, goats and poultry. Livestock production is very rare because of diseases. Although Kigoma Region is one of the very large regions in Tanzania, most of its land (approximately 1 280 780 hectares) is infested with tsetse flies leaving only about 506 000 hectares suitable for grazing (URT, 2008).

### 3.3 Research Design

A cross sectional design was used in this study. The design allows data to be collected at a single point in time and they are useful in descriptive analysis and for determination of the relationship between variables (Bailey, 1998). According to Aric *et al.* (2007), cross sectional design collects data which enable the researcher to measure prevalence for all factors under investigation and is good for descriptive analyses and for generating data required for hypotheses testing. In addition, the importance of cross sectional design is that other designs like longitudinal and multiple informants are often prohibitive for academic researchers and marketing practitioners faced with limited budgets and time. The household was selected to be the unit for empirical analysis.

### 3.4 Sampling Techniques

To obtain a sample, purposive, multi stage and random sampling were employed. The first stage involved purposive selection of two districts that is Buhigwe and Kigoma, then two divisions, one from each district were purposively selected. Then purposive sampling procedure was applied to obtain three wards: one from Buhigwe District and two from Kigoma District. The purposive and multi stage selection techniques were applied because coffee is grown in specific districts and wards. Kigoma Region is clearly divided into three agro-economic zones, the lake shore zone, the lowlands zone and the highlands zone. Arabica coffee is grown in parts of Kigoma, Buhigwe and Kibondo districts and within each district some wards do not grow coffee. According to Bless and Achila (2006), purposive sampling is appropriate to select units that are judged to be the most common in the population under investigation, for example coffee farmers. The next stage was random selection of six villages: two from each ward. After establishment of sampling frame in each village, the last stage involved proportional selection of households from each village to make a sample size of one hundred and twenty two respondents as summarized in the Table 1.

**Table 1: Sample size by district, division, ward and village in the study area**

| District | Division | Ward | Village | Number of respondents |
|---|---|---|---|---|
| Kigoma | Kalinzi | Kalinzi | Kalinzi | 21 |
| | | | Matyazo | 23 |
| | | Mukigo | Mukigo | 20 |
| | | | Nyarubanda | 19 |
| Buhigwe | Munanila | Munanila | Munanila | 16 |
| | | | Mkatanga | 23 |
| Total | | | | 122 |

### 3.5 Conceptual Framework

The conceptual framework is the researcher's idea on how the research problem will be explored, keeping in mind the theories put forth in the theoretical framework and it gives the direction to be undertaken by the researcher. Philip (2007) argues that the framework provides a guideline for identifying important variables for effective and efficient data collection. The overall objective of this study is to contribute to the efforts of improving coffee productivity to enhance smallholder arabica coffee producers' income and making a significant contribution to the economy through determination of efficiency. NGOs, Cooperatives and financial institutions, collectively play similar roles of the government. According to TCB (2011), NGOs have extensive access to expertise, funds and dedicated resources to assist smallholder arabica coffee producer improving efficiency.

Weather condition, pests and diseases influence use of agrochemicals. When there is outbreak of diseases and pests farmers increase application of agrochemicals and therefore, presence of pests and diseases lead to high cost of production and vice versa.

Information used in the analysis of technical efficiency encompass total coffee produced, inorganic fertilizers and agrochemicals, age of coffee trees, organic fertilizers and family and hired labour. Age of farmer, education level, experience of the farmer, age of coffee trees, membership in farm cooperative were useful in determining the sources of inefficiency. Information on prices of inputs and coffee enabled to determine whether the sector is profitable and hence increase income to farmers and the contribution of the sector to the economy. Fig. 4 describes the conceptual framework.

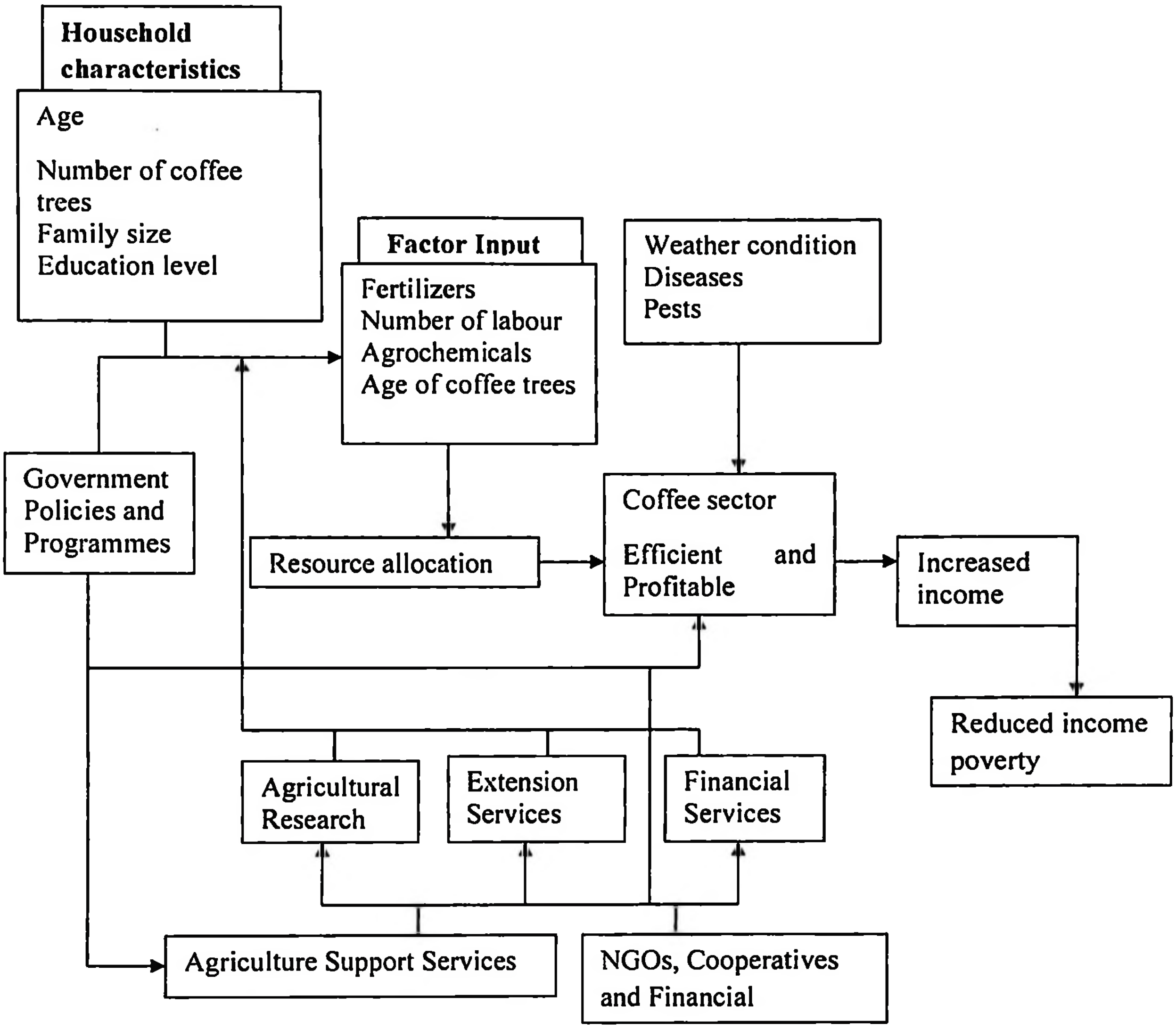


**Figure 4: Conceptual framework**

Source: Modified from Leonidas, 2000

### 3.6 Data Collection

Primary data were collected from farmers using a survey method involving a structured questionnaire. Production information collected included size of farm land owned, size of land under coffee production, type of labour used in production, like number of coffee trees, coffee harvest, prices of fertilizers and agrochemical and, family size, hired labour and seasonal yields. The socio-economic data collected included sex of respondent, age, marital status and formal education levels. Amount of credit, access to extension services, access to markets, prices of clean coffee and incomes earned from various economic activities were also collected. Data about constraints faced by coffee farmers and suggestions to increase their outputs was also collected.

Secondary data like deductions, taxes and processing costs were obtained from Manyovu, Mahwenyi, Kalinzi, Mkibanda, Mukigo, Rumako and Kanyovu cooperatives.

### 3.7 Data Analysis

The Frontier version 4.1 c, a computer program for Stochastic Frontier Production was employed to analyse the technical efficiency and the technical inefficiency effects. Microsoft excel was employed to estimate the gross margin and was useful in computing descriptive statistics which were then used to assess contribution of coffee production to household cash income and challenges facing smallholder coffee farmers in various economic activities.

#### 3.7.1 Technical efficiency and technical inefficiency effects

The parameters of the generalized Cobb-Douglas stochastic frontier for the production system were estimated using single stage Maximum Likelihood (ML) method for the technical efficiency and technical inefficiency effects. According to Murthy (2002), various econometric estimation problems, such as serial correlation, heteroscidasticity and multicolinearity can be handled adequately and easily when Cobb Douglass function is applied. According to Kebede (2011), Cobb-Douglas functional form best fits the commercial farms data set and it provides an adequate representation of the production technology. In addition, the appeal of the Cobb Douglas type of function is explained in section 2.3.1. ML method was proposed by Kumbhakar *et al.* (1991) and Huang and Liu

(1994). In early studies of ML estimation, TE was estimated using a two-stage process. First, was to measure the level of efficiency/inefficiency using a normal production function. Second, was to determine socio-economic characteristics that determine levels of technical efficiency. This was done by using a probit model, with TE as the dependant variable and the socio-economic characteristics as the independent variables. However this method was later proved to be biased hence the stochastic frontier and inefficiency models are jointly estimated. Wang and Schmidt (2002) cited by Leonard (2004) explain theoretically why two-step procedures are biased and have presented Monte Carlo evidence that such bias can be very severe.

The assumptions under ML say; the statistical noises ($v_i$s) are independently and identically distributed normal random variables with zero means and constant variance $\sigma_v^2 (v_i \sim iidN(0, \sigma_v^2))$ and inefficiency effects ($z_i\delta_i$s) are independently and identically distributed half-normal random variables with scale parameter $[\sigma_{z\delta}^2 (z_i \sim iidN^+(0, \sigma_{z\delta}^2)]$. Further, the article by Bravo-Ureta, *et al.* (1993) suggests that the stochastic frontier production function could be established in two ways. First, if no explicit distribution for the efficiency component is made, the production frontier could be estimated using a Corrected Ordinary Least Squares (COLS). However, if an explicit distribution is assumed, such as exponential, half-normal or gamma distribution, then the frontier is estimated by maximum likelihood estimates (MLE).

According to Greene (2002), MLE makes use of the specific distribution of the disturbance term and this is more efficient than COLS. In addition Greene and Wooldridge (2002), independently explain that; ML estimation is the unifying theme and the most efficient estimation procedure in the class of estimators that use information on the distribution of the endogenous variables given the exogenous variables. Aigner *et al.*

(1997) parameterized the log-likelihood function for the half-normal model in terms of $\sigma^2 = \sigma_v^2 + \sigma_{z\delta}^2$ and $\gamma^2 = \sigma_{z\delta}^2/\sigma_v^2 \geq 0$ whereby if $\gamma = 0$ there are no technical inefficiency effects and all deviations or inefficiencies from the frontier are due to noise. Using this parameterization, the log-likelihood function is given by:

$$\ln L(y|\beta,\sigma,\lambda = -1/2\ln(\pi\sigma^2/2) + \sum_{i=1}^{1}\ln\Phi(-\varepsilon_i\lambda/\sigma) - 1/2\sigma^2\sum_{i=1}^{1}\varepsilon_1^2 \text{ ..................1}$$

whereby y is a vector of log-outputs(kg), $\varepsilon_1 \equiv v_i - z_i\delta_i = \ln q_i - x_i'\beta$ is a composite error term and $\Phi(.)$ is the cumulative distribution function (cdf) of the standard normal variable evaluated at x. Therefore the generalized likelihood ratio is given by

$$\lambda = -2\ln[L(H_0)/L(H_1)] = -2[L(H_0) - L(H_1)] \text{ ..................2}$$

where $L(H_0)$ and $L(H_1)$ are the values of the likelihood function under specification of the null and alternative hypotheses, $H_0$ and $H_1$ respectively.

Cobb-Douglass production frontier is given by:

$$Y_i = f(x_i\beta_i)\exp(v_i - z_i\delta_i - w_i) \text{ ..................3}$$

$$Y_i = \beta_o\sum_{n=1}^{N}x_n^{\beta_o}\exp(v_i - z_i\delta_i - w_i) \text{ ..................4}$$

$$\ln Y_i = A + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \beta_5\ln X_5 + v_i - (\delta_1 z_1 + \delta_2 z_2 + \delta_3 z_3 + \delta_4 z_4 + \delta_5 z_5 + \delta_6 z_6 + w_i) \text{ ..................5}$$

$$\ln Y_i = A + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \beta_5\ln X_5 + v_i - \delta_1 z_1 - \delta_2 z_2 - \delta_3 z_3 - \delta_4 z_4 - \delta_5 z_5 - \delta_6 z_6 - w_i \text{ ..................6}$$

where: $Y_i$ =Cherry coffee yield expressed in kg/tree

Ln = Natural logarithms

| | |
|---|---|
| $(A = \ln\beta_o)$ | = Constant |
| $\beta_i$ and $\delta_i$ | = Unknown parameters under estimation |
| $v_i$ | = Randomness |
| $w_i$ | = TE effects which are not $iidN^{+}(0, \sigma^2_{z\delta})$ |
| $X_1$ | =Quantity of inorganic fertilizers expressed in kg |
| $X_2$ | =Value of agrochemical used expressed in TZS |
| $X_3$ | = Amount of labour expressed in man days |
| $X_4$ | = Organic fertilizer used expressed in bucket |
| $X_5$ | = Age of coffee tree expressed in number of years |
| $Z_1$ | = Experience of the farmer expressed in number of years |
| $Z_2$ | =Polytomous dummy for education level |
| $Z_3$ | = Household size expressed in number of individuals in the household |
| $Z_4$ | = Dummy variable on belonging to farm cooperative |
| $Z_5$ | = Dummy variable on farm mulching |
| $Z_6$ | =Number of coffee trees |

The technical efficiency for the $i^{th}$ firm is defined by equation:

$$TE_i = \exp(-z_i\delta_i - w_i) \quad\text{.......... 7}$$

The technical inefficiency effects model is assumed to be defined by the equation:

$$Z_i\delta_i = \delta_o + \delta_1 z_1 + \delta_2 z_2 + \delta_3 z_3 + \delta_4 z_4 + \delta_5 z_5 + \delta_6 z_6 + \delta_7 z_7 + w_i \quad\text{.......... 8}$$

### 3.7.2 Testing log likelihood properties

Fisher (1929; 1930), cited by Leonard (2004), if a normal plus half normal [$\sigma^2_v(v_i \sim iidN(0, \sigma^2_v))$ and $\sigma^2_{z\delta}(z_i \sim iidN^{+}(0, \sigma^2_{z\delta}))$] model is true, then the OLS residuals will be negatively skewed and hence the model becomes consistent with log likelihood estimation method.

$$\text{Skewness} = n^2/((n-1)(n-2)) * m_3/se^3 \quad \text{.......... 9}$$

where n is the sample size, $m_3$ is third moment and $s_e$ is standard error.

### 3.7.3 Gross margin (GM) analysis

Gross margin analysis was employed to establish amount that coffee farmers earn from the sale of their clean coffee before the deduction of any selling and administrative expenses and fixed costs. The gross output is given by output multiplied by the selling price. Variable costs included were costs of fertilizers, agrochemicals, cost of labour used in production, transport costs, sorting, curing, sacks and packaging, interest, tax, research, collateral cost and central pulpery running cost.

The following is the mathematical expression of gross margin:

$$GM_I = \sum TR - \sum TVC \quad \text{.......... 10}$$

Where:

$GM_i$=Gross margin (TZS/tree)

TR=Average total revenue (TZS/tree)

TVC=Average total variable costs (TZS/tree)

### 3.7.4 Descriptive statistics

Microsoft excel was useful in computing descriptive statistics like means, maxima, minima, frequencies and standard deviations of variables under analysis. The computed descriptive statistics were used to assess variation in technical efficiencies, variation in age of coffee trees, sources and levels of income and challenges facing smallholder coffee farmers in various economic activities.

### 3.8 Limitations of the Study

Small scale coffee farmers in Kigoma and Buhigwe districts do not keep records. This led to spending much of the time to allow farmers to recall. Also recalled data had to be computed to get required information hence there was computational problem. Data collection was done during rainy season, so it consumed more time to visit farmers. Unnecessary bureaucracy by cooperative officials made it the work to get secondary data especially on different deductions they made.

# CHAPTER FOUR

## 4.0 RESULTS AND DISCUSION

### 4.1 Efficiency and inefficiency Effects of Coffee Production

#### 4.1.1 Technical efficiency (TE)

The efficiency indices obtained are summarized in Table 2. The percentage distribution of technical efficiency for all sample data shows that there is a large variation in the level of technical efficiency among and between Kigoma and Buhigwe farmers. The mean TE for Kigoma and Buhigwe districts are 69% and 65% respectively. Although there is variation in TE efficiency indices, the differences are not statistically significant at 5%[1]. The overall mean TE for all the sample data is 68% which implies that the production on average is about 32% below the frontier. In that case, about 32% of coffee output is lost due to the specific inefficiencies pertaining to farms. Given the range of technical efficiency level, means that if the average farmer in the sample was to achieve the TE level of the most efficient farmer, then the average farmer could realize 29%[2] input savings. Also the most technically inefficient farmer could reveal input saving of 74%[3]. In addition, the technical efficiencies variations and mean technical efficiency obtained fall in line with results obtained by Joachim *et al.* (2005) on source of technical efficiency among small holder maize and peanut farmers in Cameroon and Salazar (2006) on economic analysis of Smallholder Coffee Production in Guatemala, Honduras, Nicaragua and Vietnam.

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1. The statistic value in table 2 is p=0.167

2. [(1-(68/96))*100%]

3. [(1-(25/96))*100%]

**Table 2: Summary statistics of efficiency sample from the frontier model for 2011/2012 season**

| Statistic | TE score (%) | | | p=0.167 |
|---|---|---|---|---|
| | Kigoma (n=83) | Buhigwe(n=39) | Sample(n=122) | |
| Mean | 69 | 65 | 68 | |
| Standard Deviation | 14 | 16 | 14 | |
| Minimum | 35 | 25 | 25 | |
| Maximum | 96 | 88 | 96 | |

Fig. 5 shows the percentage distribution for individual district technical efficiency. In Buhigwe sample, 2% of the farmers were operating below 25%. Going into more detail, 20% of the farmers were operating between 26% and 47% level of efficiency while only 5% farmers from Kigoma District were at the same level. The results further indicate that 41% and 39% farmers from Kigoma and Buhigwe districts respectively were operating at between 60% and 70% level of efficiency. Between 69% and 85%, 42% and 40% of respondents from Kigoma and Buhigwe districts respectively. To summarise, on average Fig 5 shows that coffee farmers from Kigoma District are more technically efficient compared to farmers from Buhigwe District.

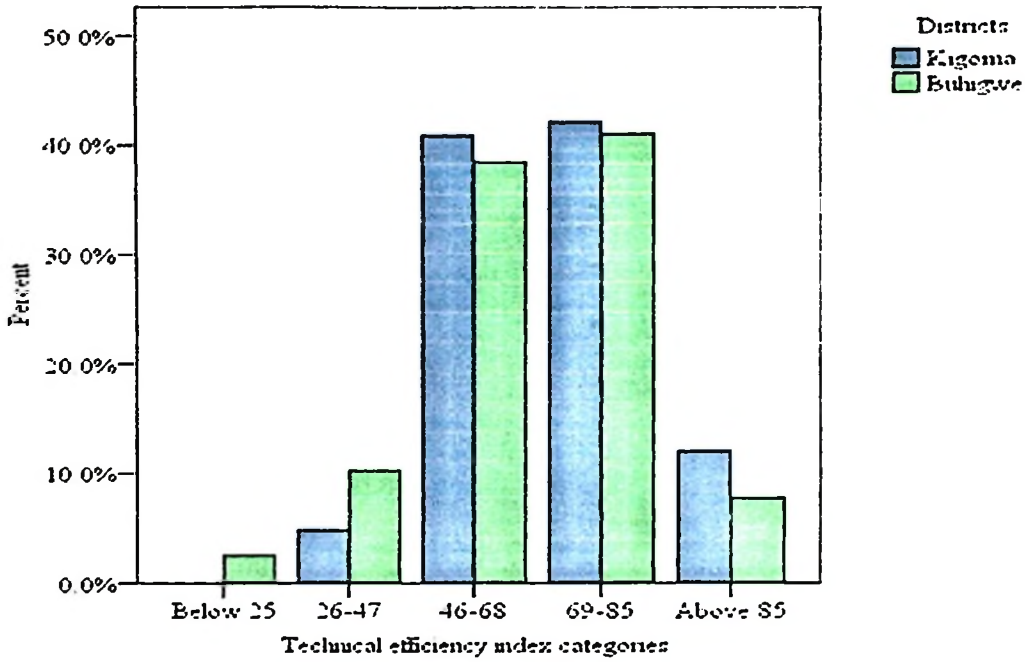


**Figure 5: Comparative distribution of technical efficiency estimates**

### 4.1.2 Input productivity and technical efficiency estimates

The Maximum Likelihood (ML) estimates for the parameters for stochastic frontier and the inefficiency model are shown in Table 5. Log likelihood function (122.2)[4] and is statistically significant at 5% level. The variance parameter of sigma square ($\sigma^2$) is 0.50 and is statistically significant at the 5% level. These indicate a good fit and correctness of the distributional form assumed for the composite error term. Table 5 provides a description of variation in TE that, technical inefficiency due to managerial decisions is about 25% ($\gamma$=0.25). This implies socio-economic decision variables contribute on average 8%[5] of technical inefficiency. Potential managerial decisions to use available inputs can enable them to achieve technical efficiency on average up to 76%[6].

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4. The critical value of the test statistic is obtained from Kodde and Palm 1986: 1246, Table 1 with degree of freedom 8 which is about 15.

5. ((100-TE) *$\gamma$=32*0.25=8)

The estimated coefficient for inorganic fertilizers (0.0848) is positive and statistically significant at 5%. This implies that increasing inorganic fertilizers by 1% will increase coffee output by about 0.0848%. The significance of inorganic fertilizers quantity is due to the fact that inorganic fertilizers determine to a large extent the output obtained. If correct inorganic fertilizer rates and quality inorganic fertilizers are not used, the output will be low even if other inputs are in abundance.

The estimated coefficient for agrochemicals (0.0758) is positive and statistically significant at 1%. This implies that a 1% increase in agrochemical will *ceteris paribus* lead to an increase of 0.0758% in coffee output. Readers must note that application of agrochemicals is determined by the prevalence of diseases and pests. If the field is free from diseases and pests, one cannot explain this situation. Furthermore, the world coffee market is increasingly concerned about chemical residues found in coffee beans, which have had an impact on human health with continuous usage. Heavy agrochemical use is not recommended because presence of toxic traces on coffee implies that its quality is already tempered with and at times when the traces are more significant, such contamination may lead to rejection in international markets like Japan, European Union and USA. According to TaCRI (2007), coffee exported from Tanzania was safe (well below the standard Maximum Residue Levels). Therefore, to maintain existing situation, farmers have to be provided with disease resistant coffee varieties to reduce agrochemicals use to maintain high quality and reduce cost of production.

The coefficient of labour is 0.8361 and significant at the 5% level. This implies that a 1% increase in labour will *ceteris paribus* lead to an increase of 0.8361 in coffee output. The estimated coefficient for organic fertilizers (0.0138) was positive but not statistically significant at 5% level.

The coefficient of age is 0.2854% and significant at 10% level. This implies that a 1% increase in age of coffee tree will *ceteris paribus* lead to an increase of 0.2854% in coffee output. Significance nature arises from the fact shown in Table 3 shows that about 47% and 53% of respondents in Kigoma and Buhigwe districts had trees with an age range between 10 to 20 years. About 16% and 8% had coffee trees aged below ten years and about 21% and 25% of respondents in Kigoma and Buhigwe districts respectively had trees whose age ranged between 21 and 30 years old. According to Parikh (1979) cited by Salazar (2006), coffee tree reaches its optimal level of production between 9 and 20 years, and declines until the age of 30 years. But with systematic stumping, coffee tree can continue to produce highly up to a maximum of 25 years and declines until the age of 40 years. Comparatively, significances of the results obtained fall in line with results obtained by Salazar (2006) on an economic analysis of smallholder coffee production in Guatemala, Honduras, Nicaragua and Vietnam[7] and Mounir and Mohamed (2006) on a stochastic frontier approach for measuring technical efficiencies of date farms in Southern Tunisia.

**Table 3: Distribution of coffee trees by age and district for 2011/2012 season**

| Statistics | Kigoma | | Buhigwe | |
|---|---|---|---|---|
| | (n) | (%) | (n) | (%) |
| Below 10 years | 13 | 16 | 3 | 8 |
| 10-20 | 39 | 47 | 21 | 53 |
| 21-30 | 18 | 21 | 10 | 25 |
| Above 30 | 13 | 16 | 5 | 14 |
| Total | 83 | 100 | 39 | 100 |

7. Significance of age of coffee tree contradicts the finding of this study.

It is well understood that variation in productivity is mainly caused by the variation in levels of soil fertility. Given this fact, soil fertility is a key variable in the stochastic production frontier analysis. Albeit its importance, the analysis does not include it because the sample was selected from the place where soil's natural fertility is more or less homogeneous (volcanic soil).

### 4.1.3 Actual output, farmers' achievable output and frontier output

Table 4 shows the statistics for the actual coffee cherry yield, expected frontier and maximum yield achievable by farmers given frontier's estimates as presented in Table 5. Table 4 shows that mean actual coffee cherry produced per tree in Kigoma and Buhigwe districts are 3.2kg and 2.7kg respectively. Maximum actual coffee produced were 8.6kg/tree and 8.4kg/tree in Kigoma and Buhigwe districts respectively. 100% efficient farmer in Buhigwe and Kigoma districts can achieve 9kg/tree and 9.6kg/tree respectively.

**Table 4: Actual output and frontier output for 2011/2012 season**

| Statistics | | Mean | Minimum | Maximum |
|---|---|---|---|---|
| Kigoma | Yield estimates (kg/tree)($Y_0$) | 3.2 | 0.1 | 8.6 |
| | Frontier cherry yield (kg/tree)($Y_0$)[8] | 4.6 | 0.4 | 9.6 |
| | TE index | 69.0 | 35.0 | 96.0 |
| Buhigwe | Yield estimates (kg/tree)($Y_0$) | 2.7 | 0.5 | 8.4 |
| | Frontier cherry yield (kg/tree)($Y_0$) | 4.1 | 2.0 | 9.0 |
| | TE index | 65.0 | 25.0 | 88.0 |

8. (100/TE*)$Y_0$

## 4.2 Socio-economic Characteristics and Technical Efficiency

So far, the analysis has only focused on the technical efficiency of stochastic frontier part of the model. Socioeconomic factors, environmental factors and physical factors are likely to affect the efficiency (Kumbhakar and Bhattacharya, 1992, Ali and Chaundry, 1990). This section reports and discusses estimates of sources of inefficiencies estimated in the frontier model.

The statistical measure of inefficiency effects ($\gamma$=0.25) is statistically significant at 5%. This implies that socio-economic farmer specific variables have significance influence on inefficiency and inefficiency variation among and between smallholder coffee farmers in Buhigwe and Kigoma districts. As explained in section 4.1.1, that about 32% of coffee is lost because of technical inefficiency. Farmers managerial decisions on production contribute about 25% ($\gamma$=0.25) to total yield losses.

The results in Table 5 show that household size, dummy for farm mulching and membership to cooperative variables have a positive sign but not statistically significant at 5% level. If these variables were significant, then they could contribute to increase in technical inefficiency. Education level has the negative sign but not statistically significant at 5% level and if it was significant, then it could influence TE positively.

The coefficient of coffee farming experience (-0.1297) is negative and statistically significant at 10%. This implies that experienced farmers are more efficient than new entrants. This finding is in line with the finding obtained by Muhammad-Lawal *et al.*, (2009) on technical efficiency of youth participation in agriculture in the Youth - in - Agriculture Programme in Ondo state, south western Nigeria where they found that early involvement in agriculture improves technical efficiency.

The coefficient for number of coffee trees (-0.0021) is negative and statistically insignificant at 5%. This implies that farmers having a large number of coffee trees are efficient compared to farmers who have few trees. This arise from the fact that farmers having a large number of tree spend much of their time working in coffee farm as well as allocating much of the resources to coffee production compared to those farmers having a few trees. This result is consistent with the findings by Overfield and Fleming (1999) on the technical efficiency of smallholder coffee producers in Papua New Guinea. They explain that the high the proportion of the total income contributed by coffee output and the more integrated into the cash economy, the more likely it is that producers strive for technical efficiency in production, and vice versa.

**Table 5: Single stage Maximum Likelihood Estimates of the stochastic frontier for 2011/2012 season**

| Variable names | Coefficient | Standard-error | Z-ratio |
|---|---|---|---|
| **Input variables** | | | |
| Constant $\beta_0$ | 1.5902* | 0.8237 | 1.9306 |
| Inorganic fertilizers ($\beta_1$) | 0.0848** | 0.3502 | 2.4212 |
| Value of agrochemicals ($\beta_2$) | 0.0758*** | 0.0204 | 3.7141 |
| Labour ($\beta_3$) | 0.8361*** | 0.1240 | 6.7440 |
| Organic fertilizers ($\beta_4$) | 0.0138 | 0.0100 | 1.3720 |
| Age of coffee trees ($\beta_5$) | 0.2854* | 0.1662 | 1.7173 |
| **Inefficiency variables** | | | |
| Constant $\delta_0$ | 0.6734 | 0.7236 | 0.93065 |
| Experience of a farmer ($\delta_1$) | -0.1297* | 0.0689 | -1.8811 |
| Polytomous for education level ($\delta_2$) | -0.4614 | 0.3412 | -0.1352 |
| Household size ($\delta_3$) | 0.0203 | 0.0603 | 0.3377 |
| Dummy for cooperative membership ($\delta_4$) | 0.6736 | 0.2469 | 0.2728 |
| Dummy for farm mulching ($\delta_5$) | 0.1906 | 0.2506 | 0.7606 |
| Number of coffee trees ($\delta_6$) | -0.0021*** | 0.0007 | -2.8034 |
| $\sigma^2$ | 0.5017*** | 0.0674 | 8.5149 |
| $\gamma$ | 0.255*** | 0.1266 | 2.0095 |
| Log likelihood function | | -0.122.3498** | |
| LR test of the one-sided error | 14.2037** | | |

*, ** and *** Significant at 10%, 5% and 1% level respectively

**4.3 Hypotheses Testing**

Test of various null hypotheses associated with the models were carried out using Likelihood-ratio (LR) statistic.

The first null hypothesis: $H_o: \lambda = z_i\delta_i = 0$, *i.e.* small holder coffee farmers in Kigoma and Buhigwe districts are not technically inefficient. The test statistic in Table 5 is 14.204 is greater than the critical value $\chi^2_{0.05}(2.7060)$[9]. Hence the null hypothesis is rejected and conclusion made is that smallholder coffee farmers are technically inefficient.

The second null hypothesis: $H_o: \gamma = 0$, *i.e.* socio-economic factors do not significantly influence the farmers' technical inefficiency. This specifies that the inefficiency effects are not stochastic. The result of the hypothesis testing for the presence of inefficiency effects is that the computed Z-ratio value is 2.0095 while the tabulated value (p=0.05) is 1.96, hence null hypothesis is rejected and conclude that the joint effects of socio-economic variables contribute to inefficiency.

Last hypothesis: $H_o: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ *i.e.* individual variable included in the inefficiency effects model have no any effect on the level of technical inefficiency. The results in Table 5 indicate that the computed Z-value for farming experience is significant at p=0.1 while for the number of coffee trees is significant at p=0.05. Education level, household size, cooperative membership and farm mulching variables are not significant at p=0.05 level. Therefore the null hypothesis is rejected because some coefficients are not equal to zero and concludes that socio-economic characteristics of small hold coffee farmers influence technical efficiency.

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9. The critical value of the test statistic is obtained from Kodde and Palm (1986: 1246, Table 1) at the 5% level of significance with degree of freedom 1.

## 4. 4 Contribution of Coffee Production to Household Income

### 4.4.1 Gross margin for coffee production

The Gross Margin (GM) analysis aims at estimating income earned from coffee farming. It is used to determine net farm income. Table 6 presents detailed farm production revenue, costs involved and the GM per coffee tree for Kigoma and Buhigwe districts.

The results indicate that there is price variation between the districts. On average, Kigoma District achieved higher price (TZS 4 810/kg) than Buhigwe District (TZS 4 540/kg). Revenue per tree was high in Kigoma (TZS 2 955) while in Buhigwe was TZS 2 238/tree. Total variable costs were TZS 2 145/ tree and TZS 1 587/tree in Kigoma and Buhigwe respectively. Labour cost per tree was very high compared to other costs; Kigoma (TZS 712/tree) and Munanila (TZS 433). The GM of coffee in Buhigwe and Kigoma districts were TZS 651/tree and TZS 810/tree respectively. The average GM in study area was TZS 730/tree. This amount is lower compared to other smallholder coffee producers. According to USAID (2010), GMs for small holder coffee producers in Kilimanjaro and Arusha were TZS 952/tree and TZS 938/tree respectively. The GM per hectare in Buhigwe and Kigoma districts were TZS 365 560 and TZS 453600 respectively. Therefore, mean GM per hectare in the study area was TZS 408 800[10].

In addition, the average GM is about 28% of average revenue earned by coffee farmers in the study area. Farmers in Kigoma earn less revenue compared to other smallholder coffee producers. For example, according to Match Maker Associates Limited (2009), coffee farmers in Ethiopia have GM of about 52% of average revenue. Also according to Ayoola (2012), smallholder coffee farmers in the Nigerian states of Kogi and Ogun receive gross margin of about 44% of average revenue. Furthermore, the distribution of levels of income

10 . Average number of coffee trees per hectare is 560 trees

earned from coffee shows that farmers with GM less than TZS 200 000 per season were 50%. Respondents earned income between TZS 200 000 and TZS 400 000 from coffee were 14%. About 7% of the respondents gained income from coffee sales between TZS 400 001 and TZS 600 000 and 29% respondents had a GM above TZS 600 000 per year.

**Table 6: Gross margin analysis result for 2011/12 season**

| District | Kigoma (n=89) | Buhigwe (n=39) |
|---|---|---|
| Total coffee output (kg) ( a) | 12 280 | 8 752 |
| Number of trees (b) | 19 171 | 16 975 |
| Output (kg/tree) (c) =a/b | 0.635 | 0.52 |
| Average price (TZS/kg) (d) | 4 810 | 4 540 |
| Revenue (TZS/tree) (e) =c*d | 2 955 | 2 238 |
| Average revenue (TZS/tree)(f)=(∑e/2) | 2 596 | |
| Cost of fertilizers TZS/tree (g) | 499 | 424 |
| Cost of manure (TZS/tree) (h) | 104 | 107 |
| Total agrochemicals cost (TZS/tree) (i) | 403 | 299 |
| Cost of labour (TZS/tree) (j) | 712 | 433 |
| Sacks TZS/tree (k) | 30 | 30 |
| Sorting (TZS/tree) (l) | 5.5 | 5 |
| CPU cost (TZS/tree) (m) | 291 | 289 |
| Total variable costs (TZS/tree) (n) | 2 145 | 1 587 |
| Gross margin (GM) (TZS/tree) (o)(e-n) | 810 | 651 |
| Average gross margin (TZS/tree) (p)=(∑o/2) | 730 | |
| Proportion of GM to average revenue (p/f)% | 28 | |

### 4.4.2 Proportionate contribution of all sources of cash income sources

Table 7 shows the proportionate contribution of income generating economic activity to household income in the study area. Comparatively, coffee contributes higher in Kigoma (40%) than in Buhigwe (37%). Existing differences in contribution of different sources of income is not statistically significant at p=0.05 (p statistic=0.137). Overall, across the two districts, only 39% of cash incomes were derived from coffee. The largest contribution to household income was from bananas whose contribution was 45%. Small business appears to be third cash income contributor with 8% of total cash income earned by coffee farmers in the study area. Horticulture, formal employment and animal keeping contribute 3%, 3% and 2% of total cash income respectively. Formal employment, small business and animal keeping provide computable amount but both are very limited in the study area. The contribution of coffee to cash household income is consistent with the findings by USAID (2010) on Tanzania coffee industry value chain analysis which found that on average coffee contributes about 37% of total cash income.

In addition, the highest cash earner got annual average cash income of about TZS 8 237 575, while the least earner got mean annual cash income of about TZS 20 000 and mean earners had about annual cash income of TZS 1 276 175. The average cash earning from coffee production was TZS 770 548 and maximum was TZS 3 485 446. About 19% of respondents experienced losses from coffee farming in 2011/12 production season. The average cash earning from banana production was TZS 342 754 and maximum was TZS 1 125 000. Minimum earner from bananas achieved annual cash income of about TZS 20 000.

**Table 7: Proportionate contribution of all sources of income sources in Buhigwe and Kigoma districts for 2011/2012 season**

| District | Statistic | Coffee | Bananas | Horticulture | Employment | Animal | Business |
|---|---|---|---|---|---|---|---|
| Kigoma(n=83) | Mean | 819 006 | 343 792 | 118 450 | 4 200 000 | 626 666 | 945 384 |
| | Minimum | | 60 000 | 20 000 | 2 400 000 | 500 000 | 230 000 |
| | Maximum | 333 4647 | 1 125 000 | 450 000 | 6 600 000 | 750 000 | 3 600 000 |
| | % | 40 | 44 | 3 | 4 | 3 | 8 |
| Buhigwe(n=39) | Mean | 819 006 | 343 793 | 118 450 | 4 200 000 | 626 666 | 945 385 |
| | Minimum | | 60 000 | 20 000 | 2 400 000 | 500 000 | 230 000 |
| | Maximum | 333 4647 | 1 125 000 | 450 000 | 6 600 000 | 750 000 | 3 600 000 |
| | % | 37 | 53 | 3 | | | 6 |
| Sample(n=122) | Mean | 770 548 | 342 754 | 73 972 | 4 200 000 | 626 667 | 855 263 |
| | Minimum | | 20 000 | 12 000 | 2 400 000 | 500 000 | 230 000 |
| | Maximum | 3 485 446 | 1 125 000 | 450 000 | 6 600 000 | 750 000 | 3 600 000 |
| | % | 39 | 45 | 3 | 3 | 2 | 8 |

## 4. 5 Challenges faced by small hold coffee farmers in the study area

### 4.5.1 Few and distant located central pulpery units

Quality improvement requires a well prepared area for cleaning, cheering out, drying transport and storage. Coffee quality in Kigoma has remained a problem to farmers. About 50% of the total coffee produced is home processed leading to low price because of its low quality. According to TCB (2011), price premium can be increased by better coffee quality improvement.

Farmers have failed to adhere to good agricultural post harvest practices and improvement because of few and distant located central pulpery units. Home processed coffee from both districts received lower price than CPUs processed coffee. Kigoma District received higher prices from both coffees than Buhigwe District. During the interview, about 67% of the respondents reported that distant and few central pulpery centers are a big challenge to coffee improvement. Table 8 shows that 50% of coffee was processed at CPU and farmers received mean price of TZS 5 653/kg while home processed was TZS 3 625/kg.

Notwithstanding the current situation of coffee processing in Kigoma, the status is impressive as per Tanzania Coffee Industry Development Strategy 2011-2021 which aims at processing about 70% of coffee at CPU by 2021. Current average CPU coffee processed is 35%.

The present study found three scenarios: first was home processed (HP), second was CPU processors and the last one was both home and CPU processors. In analysing the Quality Improvement Gains (QIG), scenario one and two were used. Table 8 shows the quality improvement gains is TZS 1 430/kg[11]. Responses of farmers on why they don't send their coffee to CPUs were because of distant location of centers and congestion at centers. Also previous price difference was not as high as reported price during the current research, hence farmers decided not to send their produce to CPUs. This finding is consistent with the findings by USAID (2010) on Tanzania coffee industry value chain analysis with conclusion that increasing processing units (CPUs) is very crucial, otherwise smallholder coffee farmers will continue hearing about good coffee prices and not accessing them.

11. About 39% of price of home processed coffee

**Table 8: Coffee processing, prices and quality improvement gain (QIG) for 2011/2012 season**

| District | CPU Processed (kg) | Price | Home Processed (kg) | Price |
|---|---|---|---|---|
| Kigoma(n=83) | 350 770 | 5 699 | 303 599 | 3 599 |
| Buhigwe (n=39) | 132 177 | 5 563 | 118 092 | 3 677 |
| Total | 482 947 | | 489 047 | |
| | | | | |
| % of CPU of total coffee produce | | 50 | | |
| Mean price | | 5 653 | | 3 625 |
| | | | | |
| Quality Improvement Gains for coffee processed at CPUs | | | | |
| Transaction costs | | | | |
| CPU costs (TZS/kg) | | 472 | | |
| Expected loss(0.001*Price) (TZS/kg) | | 6 | | |
| Transport mean cost(TZS/kg) | | 200 | | |
| Total costs(TZS/kg) | | 598 | | |
| QIG (TZS/kg)[12] | | 1 430 | | |

### 4.5.2 High cost of inputs

Coffee production requires high inputs application to increase production and productivity. Cost of fertilizers per bag of 50kg was between TZS 65 000 and TZS 90 000. Types of fertilizers used includes: Urea, CAN and DAP. Agrochemicals are highly used because the area suffers from diseases and pests. Agrochemicals which are frequently used include Byton, Thiodan, Selecton, Blue Copper, Sumithion, Red Copper, Cobox, Dusban, linkon, Dume and Banko. About 96% of the respondents see inputs being the first bottleneck to increasing coffee production. High cost incurred in purchasing inputs made some farmers to purchase less inputs and hence poor coffee harvest. Fi. 5 shows fertilizer application per hectare that, 39% of respondents applied more than 150kg, 16% farmers applied between 101 and 150kg, 28% of respondents applied between 51 and 100kg and 17% used less than 50kg. Mean fertilizer application was about 154kg per hectare.

12. QIG=CPU Price-Home processed price-total transaction costs involved in coffee processing at CPU.

### 4.5.3 Taxes and other deductions

The present study observed that the direct tax burden and other deductions in coffee is high hence reducing farm gate price. About 78% of the farmers interviewed expressed that taxes were key to reducing their income. Taxes include: VAT, collateral and research which sum up to TZS 270/tree. In section 4.4.1, the GM analysis shows that the on average the gross margin per tree is TZS 757 and total taxes was about TZS 227/tree. Comparing mean GM with taxes, then tax burden is about 30%[13]. The study by World Bank Group (2009) done in Tanzania shows that an average tax burden in coffee was 5% while the record was very high in cashew nuts (22%). Actually high tax burden is not a standalone factor rather contributed by the low price of coffee produce, low yield and high prices of fertilizers and agrochemicals.

### 4.5.4 Other challenges encountered in coffee production

Table 9 presents a summary of other challenges encountered by smallholder coffee farmers in their day-to-day farming activities. Regarding the extension services, about 71% of the respondents reported it as an important obstacle to their farming activities. Transport costs in the country are fairly high. High transport cost means that the profitability of coffee production decreases with increasing distance from the CPU, factory and Auction in Moshi. About 62% of the respondents reported transport as bottleneck to coffee marketing. It was noted that about 50% of the interviewed producers of coffee expressed their concerns about high interest rate. The interest rate is payable from the first installment that farmers are paid after clean coffee shipment to the port or auction in Moshi.

13. Tax burden=Total taxes/Mean gross margin

Furthermore, Table 9 shows that the numbers of respondents who reported payment delays as an important challenge was about 79% of the interviewees. The fact remains true because in 2011/12 production season, last auction sale was November 2012 but final payment was made during March 2013. About 74% of the respondents reported unknown and unstable coffee market and their wish was coffee buyers to visit them and negotiate price unlike the prevailing system whereby the apex cooperative negotiate on behalf of the primary cooperatives. Generally the challenges facing coffee farmers in Buhigwe and Kigoma districts are consistent with findings by BACAS (2005) on contribution that coffee makes to the well-being of these families, and the social and economic factors that contribute to the sustainability and success of their contrasting agricultural and livelihood systems in Arusha, Kilimanjaro, Kagera and Ruvuma and USAID (2010) on Tanzania coffee industry value chain analysis.

**Table 9: Other challenges encountered in coffee production for 2011/2012 season**

| Challenge | Respondents | |
|---|---|---|
| | (n) | (%) |
| Extension services | 87 | 71 |
| Transportation | 76 | 62 |
| High interest rate to first installment | 61 | 50 |
| Payment delay | 96 | 79 |
| Unknown and unstable market of coffee | 96 | 79 |

# CHAPTER FIVE

## 5.0 CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Conclusions

Results show that the overall mean technical efficiency is 68%. Therefore, there is a 32% scope for increasing coffee production by using the present technology. Managerial decision variables can enable farmers to achieve on average up to 76% of technical efficiency. Furthermore, results show that all inputs contribute statistically and positively to yield with exception to organic fertilizer. This implies that farmers were applying inputs below the optimal levels. Hence production can be increased by improving technical efficiency and increased inputs use.

Household socioeconomic decision variables have been evaluated and the estimates show that farmers' decisions variables significantly influence technical inefficiency and inefficiency variation levels among smallholder coffee farmers. Farming experience (-0.1297) and number of coffee trees (-0.0021) are very crucial in improving technical efficiency.

Coffee production is very crucial in improving house hold cash income in study area (39%). The mean gross margin per tree was TZS 730 which is a good indicator for sectoral profitability. Conclusion made is that coffee production is profitable and contributes significantly to household cash income.

Lastly, the present study also identified the main challenges encountered by farmers in the study areas. The results show that there are eight main challenges which were reported by at least 50% of the respondents. The main challenges which were reported by farmers are: high prices of inputs (96%), taxes and other deduction (78%), shortage of extension services (71%), unreliable markets and low coffee price (74%), few and distant located central pulpery units (67%), transport problem (62%), payment delay (78%) and high interest rate (50%). The large proportions of farmers reporting the high price of inputs, taxes and other deductions, shortage of extension services, unreliable markets and low coffee prices and few and distant located central pulpery units make it reasonable to conclude that they are among the main challenges encountered by the producers of arabica coffee in Buhigwe and Kigoma districts.

## 5.2 Recommendations

Based on the findings of this study, the following six recommendations are hereby proffered:

First, expansion of coffee farms is very important to technical efficiency improvement. This is because results show that the increased numbers of coffee trees significantly improve efficiency. This finding is very useful to Tanzania Coffee Board in implementation of Tanzania Coffee Industry Development Strategy 2011-21 which aims at increasing 20 million seedlings and supply them to farmers by 2021.

Second, efforts should be made to influence youth participation in coffee production to have experienced farmers for technical efficiency improvement. To achieve this strategy, the youths should be assisted to have better access to the necessary inputs of production such as fertilizers, land and agrochemicals. To improve their skills and knowledge in coffee production, they should be assisted to acquire better and effective training through participation in training programmes and workshops. Thus, high productivity and income will be gained through increased efficiency in the use of existing farm technologies.

Third, there is a need to supply high disease resistant coffee varieties to reduce high rate of application of agrochemicals to reduce chemical residues for maintaining high coffee quality. This will enable coffee to fetch high price and reduce cost of production.

Fourth, fertilizers supply must be subsidized by the government so that all farmers achieve the agronomic requirement of coffee plants. Hence productivity should be improved through good farming methods and efficient use of inputs. Therefore, policy makers should concentrate on policies that increase the level of technical efficiency of farmers. Also other actors such as non-governmental organization should encourage farmers to improve the allocation of inputs to enable them get the highest output feasible moving toward the production frontier.

Fifth, increasing gross margin and high contribution of coffee on household income requires production efficiency and cost effective marketing. Therefore the present study recommends that stakeholders should help farmers to produce at the least cost. Furthermore, improvement of income requires local government to reconsider taxes, Tanzania coffee board to reduce deductions and Tanzania Revenue Authority to reconsider tax rate.

Sixth, increased and efficient use of CPUs rather than using hand pulpers would enable farmers to fetch premium prices and hence significantly raise incomes. This must go together with inspections to ensure that coffee buyers are consistently purchasing a high quality product. This will be easily achieved if Tanzania Coffee Industry Development Strategy 2011-21 is well implemented as per its section 4.2 which says that: the price premium shall be increased by producing best coffee quality. This will require farmers` adherence to good agricultural practices and improvements in the utilization and investment in central pulpery units.

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# APPENDICES

## Appendix 1: Summary of researches used Cob Douglas production frontier

| Authors | Title of the study | Determinants of TE | Results TE (%) |
|---|---|---|---|
| Msuya *et al.*, 2008 | Explaining Productivity Variation among Smallholder Maize Farmers in Tanzania. | | 56 |
| Coelli and Battese, 1996 | Identification of factors that influence the technical inefficiency of Indian farmers | Farm size, farmer's age and education level of farmers | 73 |
| Cardenas, 2004 | Efficiency analysis of coffee production in Veracruz, Mexico. | Education, farm size, fertilizers, extension services and labour | 15 |
| Binam, Tonye and Wandji, 2005 | Source of technical efficiency among small holder maize producers in slush and burn agricultural zone in Cameroon | Land, hired labour and capital | Ranges between 55 to 99 |

**Appendix 2: Questionnaire**

Title: Production Efficiency of Arabica Coffee Smallholder Farmers in Kigoma and Buhigwe districts, Tanzania

Questionnaire number............................ Date of interview.......................

District..............Division................. Ward...................Village.................

A: Household variables

1. Name of household head.................................2. Age .........years
2. Education level of Household head...................

Non formal ( ) (b) Primary education ( ) (c) Secondary education ( ) (d) College ( ) (d) other (mention)...............

3. Household composition

| S/N | Age | Gender | Education level | Occupation |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

**B: Household farm activities**

4. How many years have you been coffee farming? (years)....................................
5. What other crop do you grow?............................................................

.............................................................................

6. Where do you obtain coffee seedlings? (a)Own raised ( )

(b) Buy from private seed beds ( ) (c) cooperative ( ) (d) TaCRI centre ( )

7. What is the age of your coffee trees in years?

| Age | Number of trees | Age | Number of trees |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

8. After how many years from time you plant seedlings, you start harvest coffee cherry?..................

**C: Production inputs**

9. How did you acquire land?

Inherited (    ) ---------acres (b) bought (   ) ........acres (c) Hired (   )........acres

10. How do you allocate your land to different farming activities in last season (2011/12)?

| Crop | Acres | Crop | Acres |
|---|---|---|---|
| Coffee/Banana | | Cassava | |
| Banana | | Beans | |
| Maize/Beans | | Others(specify) | |
| Horticulture | | | |

11. How did you allocate labour for coffee farming activities? Indicate in the table below.

| Activity | Family | Hired | | Requirement |
|---|---|---|---|---|
| | Man days | Man days | Payment per labour | |
| Weeding | | | | |
| Fertilizers application | | | | |
| Mulching | | | | |
| Agrochemicals application | | | | |
| Pruning | | | | |
| Harvesting | | | | |
| Pulping and sorting | | | | |
| Transportation | | | | |

| | | | | |
|---|---|---|---|---|
| Other activity(specify) | | | | |
| | | | | |

12. May you please indicate type input (inorganic and organic), sources, and unit prices for last season (2011/12)?

| Input | | | Sources | Quantity | Unit price |
|---|---|---|---|---|---|
| Fertilizers | Inorganic | DAP | | | |
| | | Urea | | | |
| | | CAN | | | |
| | | Others | | | |
| | | | | | |
| | Organic | Manures | | | |
| | | | | | |
| Agrochemical | | | | | |
| | | | | | |
| | | | | | |
| Mulching | | | | | |
| Sacks | | | | | |

13. Source of inputs: 1=stockiest 2=cooperative 3=others (specify)...............................

D: Output and sales

14. How much coffee did you harvest from your farm last season (2011/12).................. (kg)

15. Where did you curry you coffee last season?

a) Home ( ) Kilograms curried.....................................

b) CPU ( ) Kilograms curried.....................................

16. Where did you sell coffee beans? (a) Private traders ( ) (b) through cooperatives ( ) (c) own growing ( ) (d) Other farmers ( )

17. Indicate buyer, quantity sold and price fetched from each buyer.

| s/n | Buyer | Quantity (kg) | Price per kg(TZS) |
|---|---|---|---|
| 1 | Private trader | | |
| 2 | Cooperative | | |
| 3 | Other farmer | | |
| 4 | Other (specify | | |

18. How do you obtain information coffee market price?

Direct visit to the market ( ) (b) From other farmers and friends ( )

Government officials ( ) d) Traders ( ) (e) NGOs ( )

**E: Other farm activities**

19. Indicate how you applied labour to other farm activities

| Crop /Animal | Activity | Family | Hired | |
|---|---|---|---|---|
| | | Man days | Man days | Payment per labour |
| Cassava | | | | |
| | | | | |
| | | | | |
| Maize | | | | |
| | | | | |
| Horticulture | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Cattle | | | | |
| | | | | |
| | | | | |
| | | | | |
| Sheep/goat | | | | |
| | | | | |
| | | | | |

20. May you please indicate type inputs for last season (2011/12)?

| Input | | | Quantity (kg or litre) | | | |
|---|---|---|---|---|---|---|
| Crops | | | Maize | Beans | Horticulture | Other (specify |
| Fertilizers | Inorganic | SA | | | | |
| | | Urea | | | | |
| | | TST | | | | |
| | | Others | | | | |
| | | | | | | |
| | Organic | Manures | | | | |
| | Other | | | | | |
| Agrochemical | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| Animals | | | Cattle | Goat | sheep | Other (specify) |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

21. Indicate other farm output sold: quantity and price

| Output | Quantity | Price | Output | Quantity | Price |
|---|---|---|---|---|---|
| Banana | | | Goat | | |
| Cassava | | | Sheep | | |
| Cattle | | | Beans | | |
| Maize | | | Others (specify) | | |
| Horticulture | | | | | |

**F: Nonfarm sources of income**

22. What are other sources of income, apart from farming activities? Indicate in the table below

| s/n | Activity | Total income on average per month |
|---|---|---|
| A | Business | |
| B | Civil work | |

23. What was your source(s) of startup capital?

..........................................................................................................

..............................................................................................................

...............................................................................................

**G: Supporting services**

24. Arc you a member of cooperative? (a) Yes ( ) (b) no ( )

25. If yes, what services do you rcceive from cooperative?

..........................................................................................................

............................................................................................

26. How many times did you obtain advice about coffee from extension agents in the last season (2011/12)?................................

27. Have you attended other training on coffee farming apart from normal education system? (a) Yes ( ) (b) No ( )

28. If yes indicate in the following table

| s/n | Training was about.... | Duration | Facilitator(s) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

29. Is there any organization providing credit in term of inputs or capital to farmers?

Yes b) No ( )

30. If yes, indicate the organization, type of service and amount you received in the last season.

| s/n | Organization | Type of services | Amount received | Accompanied Condition |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

31. On your opinion, are the services provided adequate?

1=adequate 2=partially adequate 3=not adequate ( )

**H: Household welfare**

32. What are the benefits you get by farming coffee?

.................................................................................................................

...................................................................................................

33. How is your income from coffee farming activities in past five years?

Increasing b) decreasing c) no change ( )

**I: Problems**

34. What are the most challenges do you face in your daily economic activities?

Farming activities.........................................................................

...............................................................................................................

...............................................................................................................

...............................................................................................................

.....................................................................................

Nonfarm activities...................................................................

.................................................................................................

.................................................................................................

......................................................................................................

35. How do you solve these challenges?

..........................................................................................................
..........................................................................................................
..........................................................................................................
...............................................................................

36. What is your future plan concern coffee farming?

Improving input usage ( ) (b) increasing number of coffee trees ( )

(c) Reducing number of tree ( ) (d) shifting to other activity ( )

37. Please give your general opinion on coffee farming

..............................................................................................

..............................................................................................

...................................................................................................
...................................................................................................
...................................................................................................
...........................................................................

**Thank you very much for your cooperation**