

**PRODUCTIVITY ANALYSIS OF SMALL SCALE COTTON
FARMS IN BARIADI DISTRICT, TANZANIA**

By

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**A Dissertation Submitted in Partial Fulfillment of the Requirement for Award
of the Degree of Master of Science in Economics (MSc ECO) of Mzumbe**

University

2017

CERTIFICATION

We the undersigned, certify that we have read and hereby recommend for the acceptance by Mzumbe University a dissertation entitled: “***Productivity analysis of small scale cotton farms in Bariadi District, Tanzania***”, for partial fulfillment of the requirements for the award of degree of Master of Science in Economics (MSc. ECO) of Mzumbe University

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DEDICATION

This dissertation is dedicated to my parents; my father Mr. William Kayanda and mother Ms Mariam Kitundu who laid the foundation to my education. It is also dedicated to my lovely wife, Balbina; my sons William and Christian; my daughters Msua and Neema. “God bless you all abundantly”.

ACCRONYMS AND ABBREVIATIONS

AE	Allocative Efficiency
CIIP	Cotton Industry Implementation Plan
CLRM	Classical Linear Regression Model
DEA	Data Envelopment Analysis
DFA	Distribution Free Approach
EE	Economic Efficiency
ECGA	Eastern Cotton Growing Area
FAO	Food and Agriculture Organization
FDH	Free Disposal Hull
HA	Hectare
MLE	Maximum Likelihood Estimation
NGO	Non-Government Organization
SFA	Stochastic Frontier Approach
SPSS	Statistical Package for Social Sciences
TCB	Tanzania Cotton Board
TE	Technical Efficiency
TFA	Thick Frontier Approach
UNESCO	United Nations, Educational, Scientific and Cultural Organization
URT	United Republic of Tanzania
WCGA	Western Cotton Growing Area

ABSTRACT

Tanzania cotton production in the globe has declined and reduces its competitiveness as a result of low productivity experienced over the past 10 years; it was found that among the reasons for low cotton productivity are issues related to inefficiency on inputs distribution, usage and adherence to good agricultural practices.

Based on the existing situation, this study intends to analyse productivity of small scale cotton farms in Bariadi district. The study involved a sample of 128 farmers and had the following specific objectives, (i).To determine the level of technical efficiency of small scale cotton farmers in Bariadi (ii) To examine the effects of household level factors on technical efficiency of the small scale cotton farmers in Bariadi district. (iii) To examine the effects of farm level factors on technical efficiency of the small scale cotton farmers in Bariadi district. These objectives were analysed through the use of Cobb Douglas Stochastic Production Function and FRONTIER 4.1 program as econometric tools and the estimation used Maximum likelihood estimation techniques.

Regression results indicated technical efficiencies value of small scale farmers in the study area to range from 0.05 to 0.95 with mean efficiency of 0.69. Furthermore technical efficiency was found to be influenced positively by household's total income, farming experience, Household size of the farmer and access to extension services. Cultivation cost and marital status (divorced) contributed negatively on technical efficiency of farmers whereas farmers' education and sex of farmer had results that were statistically insignificant in determining the level of technical efficiencies of farmers in the study area.

The study recommends various actions by the government and all other key stakeholders of cotton in order to improve technical efficiency and cotton productivity in the study area. Such actions should aim at improving access to extension services, improve mechanization in cotton production, increase women involvement, and improve education level of farming communities.

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CHAPTER ONE

INTRODUCTION AND OVERVIEW

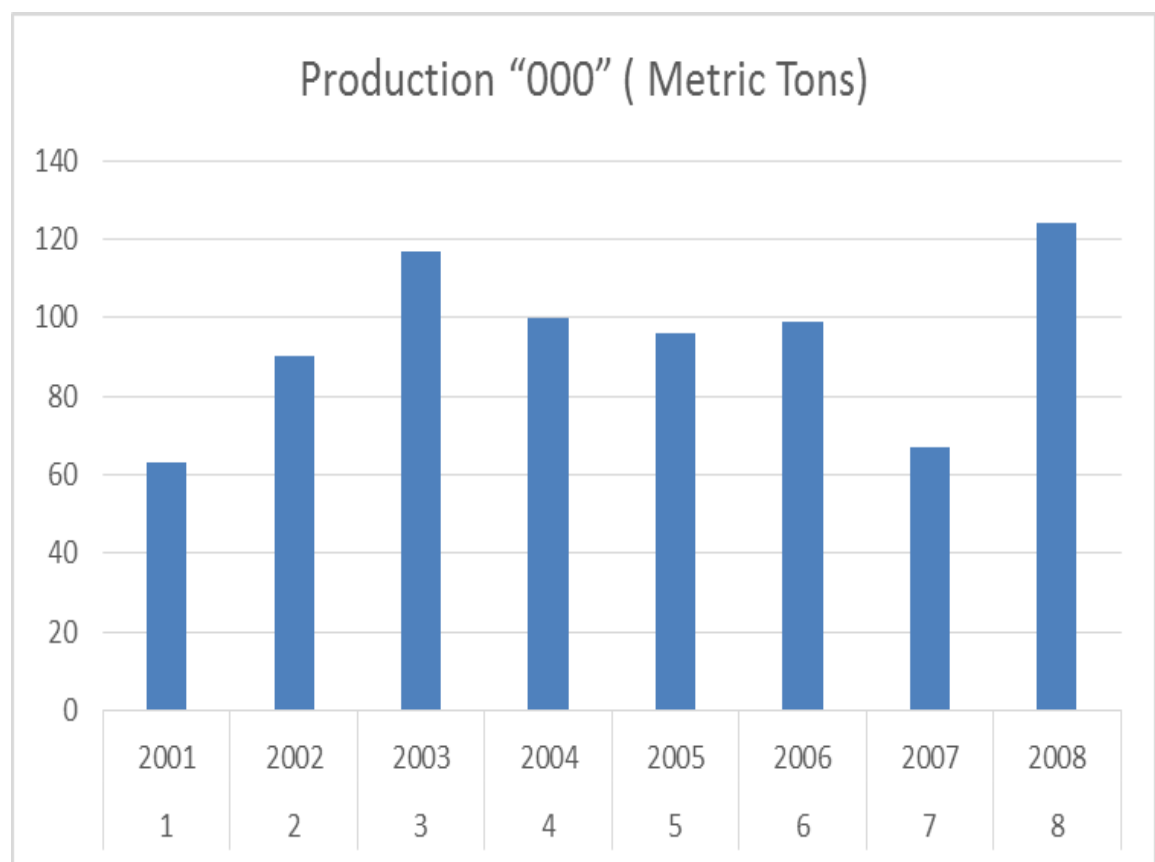
1.1 Background to the problem

Cotton is one of the most important cash crops produced globally. The global cotton enterprise includes greater than one hundred million farm families throughout 75 different countries, and generates approximately USD 51.4 billion yearly in unprocessed cotton (FAO, 2015). According to Baffes, (2004) more than two thirds of the world's cotton is produced by developing countries. Wilson (2006) indicates that in 2005/06, total cotton production in Africa was 1.7 million tons of lint, which equals to 7% of world production and worth approximately \$2 billion to African countries economies. Total cotton export for African countries accounted for 17% of world exports. In the Francophone international locations (international locations that use French as authentic language) of West and Central Africa, cotton production accounted for 4% of world cotton production and 11% of worldwide exports. East and Southern Africa Cotton accounted for 2% of production and 4% of exports.

Cotton production in Tanzania started about 120 years, and it was introduced by German colonialists in the late 19th century. It is one of the major country's cash crops others are coffee, tea, tobacco, cashew nuts, and sisal. Its contribution to agricultural growth and earnings is remarkable, Tanzania Cotton Board (2010). Cotton farming in Tanzania is mainly practiced by smallholder farmers on farms with size ranging from 0.5 to 10 hectares with an average of 1.5 hectares (Baffes, 2002). Busi, Conrad, Lyaro and Matto (2008) indicate that the cotton growing area in Tanzania is divided into two zones which are West and East and they are termed as Western Cotton Growing Area (WCGA) and Eastern Cotton Growing Area (ECGA) respectively. The WCGA include regions of Mwanza, Shinyanga, Singida, Mara, Kagera and Tabora producing about 95% while the ECGA include Morogoro, Manyara, Tanga and Kilimanjaro regions with a low production of about 5% of the

total cotton produced. Due to increase of administrative units, Simiyu region which was established in 2012 is one of the regions under the WCGA which formerly was included as part of Mwanza and Shinyanga regions before its establishment. In Tanzania cotton production is mostly practiced using hand hoe techniques, with some animal traction for soil preparation as well as during planting and in subsequent weeding. In some few cases farmers also use tractors which contribute to the employment of modern farming techniques. Cotton cultivation in Tanzania for most time now has been practiced using UK 91 type of cotton seed in WCGA since 1991. New varieties UK 08 and UKM 08 have also been released recently. Another type of seed which is Mkombozi (ALAI 90) has been in use since 2002. TCB (2010) provides data showing the trend of cotton production in Tanzania from 2001 to 2008 in figure (1.1) below.

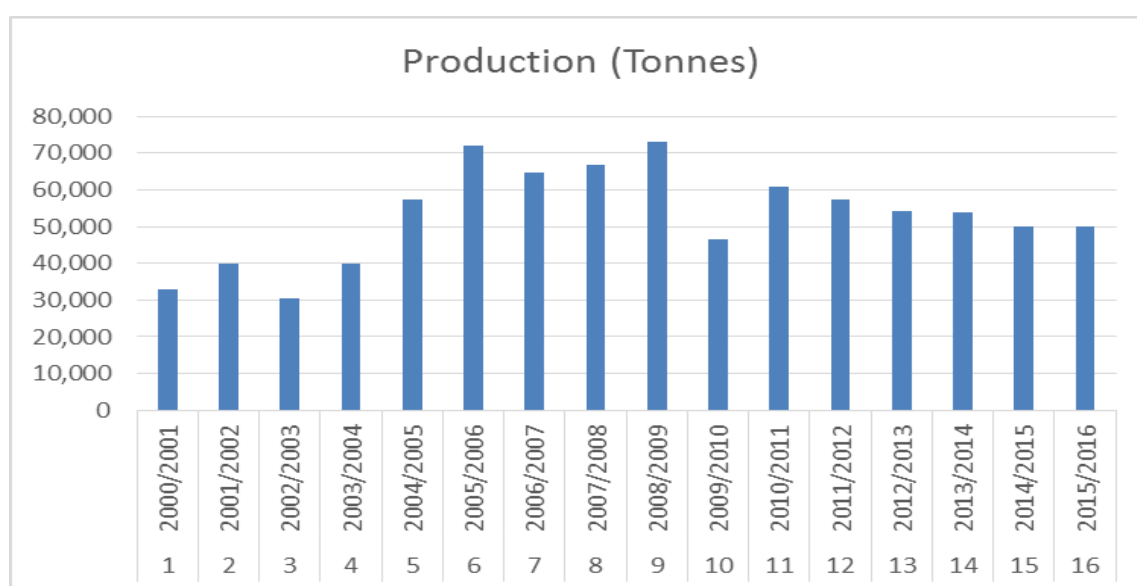
Figure1.1: Cotton production trend in Tanzania from 2001 to 2008



Source: Cotton board of Tanzania, 2010

Bariadi district is one among districts which produce cotton in Tanzania. Currently, the district produces about 20% of the total cotton in Tanzania, making it the top District for the sub-sector in Tanzania, Sigalla, Cuvelier and Rüegg (2011). However cotton productivity has declined since the 1980s, when the District contributed up to 40% of the national production. Cotton production fluctuation in Bariadi district is obviously seen as it is in the decline of the overall Tanzania cotton productivity due to the fact that total productivity of cotton in Tanzania depends on productivity from other small units of regions and districts and therefore fluctuations of production in districts and regions affect the total production. Figure 1.2 below shows the trend of cotton production in Bariadi district for some selected years.

Figure 1.2 Cotton production trend in Bariadi district from 2000/2001 to 2015/2016



Source: Bariadi District Council, 2015

TCB (2010) reveals that cotton is a cash crop grown in Tanzania and it is a source of employment and livelihood to about 40% of the population, that means about 16 million people depend cotton as their means of livelihood; these people depending cotton for their livelihood may be farmers, cotton ginners and merchants, inputs suppliers, researchers, other cotton processors and service providers, clothes

wholesalers and retailers together with their dependents. The importance of cotton production to Tanzanian economy is further insisted by TCB (2010) whereby in 2008 cotton production generated US\$ 115 millions in foreign exchange earnings; compared with US\$108.1 million (tobacco), US\$ 97.5millions (coffee), US\$ 40.8millions (tea) and US\$ 40.2 million (cashew nuts).Generally cotton can be a hub for forward and backward linkages in agro- processing Industrialization; further employment creation and value addition, provision of a sustainable manufacturing industrial base.

1.2 Problem Statement

Tanzania cotton production has been declining for a long period now and the share of Tanzania cotton to different markets in recent years has been declining as a result of low productivity. For instance, in 1974 the country contributed about 60 % of the world's average yield, however in 2014/2015 the country's share in Eastern Africa and Sub-Saharan Africa cotton production was 28% and 7% respectively while its contribution to the world's average yield was only 25%. It was found that among the reasons for low cotton productivity are issues related to inefficiency on inputs distribution, usage and adherence to good agricultural practices. Since the gap of productivity between Tanzania and other countries has been widening and reduce the country's competitiveness, Therefore one strategy of improving productivity and competitiveness of cotton in Tanzania is through addressing issues of cotton productivity and efficiency together with other initiatives (URT, 2016).

Several studies have been carried out all over the world on cotton productivity related matters, but most empirical studies in Tanzania such as Nsindagi (2015), Ilembo and Kuzilwa (2014) and Kidane, Hepelwa, Tingumand Hu (2013) have been conducted concerning productivity and efficiency related matters for crops like tobacco, maize, groundnuts, sugarcane and rice; studies which involved cotton crop mostly did not consider the issue of technical efficiency; for instance Mshana (2014) conducted an assessment of constraints in the adoption of organic cotton production

practices in Meatu District; Mkumbo, (2014) investigated the effects of cotton market decline on people's welfare in Bariadi district; Lupimo, (2013) conducted economic viability of cotton production in Magu District. Despite the fact that cotton productivity is so important in improving farmers' welfare, few studies have been conducted on this aspect and most of them applied non parametric approach with econometric models such as Tobit. Therefore in particular this study applied a parametric approach through the use of the Stochastic Frontier (Cobb Douglas) Production Function.

1.3 Research Objectives

1.3.1 General objective

Main objective of the study was to analyze small scale farm productivity in cotton production in Bariadi district.

1.3.2 Specific objectives

1.3.2.1 To determine the level of technical efficiency of small scale cotton farmers in Bariadi district.

1.3.2.2 To examine the effects of household level factors on technical efficiency of the small scale cotton farmers in Bariadi district.

1.3.2.3 To examine the effects of farm level factors on technical efficiency of the small scale cotton farmers in Bariadi district.

1.4 Hypothesis formulation

Hypotheses are developed by linking the concepts from theoretical literature review, empirical literature review and conceptual framework. Their importance is related in testing the validity of variables of the conceptual framework. This study developed and tested the following hypotheses.

H1: Small scale cotton farmers in Bariadi district are fully technical efficient.

H2: Household level factors have no effect on technical efficiency in cotton production among small scale farmers in Bariadi district

H3: Farm level factors have no effect on technical efficiency in cotton production among small scale farmers in Bariadi district

1.5 Scope of the Study

This study is focused on the analysis of productivity in small scale cotton farms in Bariadi district. Designed self-administered questionnaires were used in collecting responses from the small scale cotton producers in the study area. The conduction of the study involved different stages (steps) like proposal writing, data collection, data analysis and final report writing.

1.6 Significance of the Proposed Study

Studying the analysis of cotton productivity to small farms in Bariadi has great impact on improvement of cotton productivity in the study area as well as productivity in Tanzania as a whole. Understanding of the concept and applicability of technical efficiency among small scale cotton farmers in the study area is so important in understanding the level of technical efficiency scores of farmers, identifying the gap that is available for more exploitation, enhancing optimal use of different inputs such as seeds, fertilizers, pesticides, machinery and equipment. It also helps small scale farmers to understand factors that influence technical efficiency. The study not only contributes to the body of knowledge but also provides suggested area for further research. It also provides information to all stakeholders about their influences on cotton productivity in the study area and their roles in improving cotton productivity. The study provides recommendations to various critical challenges of cotton productivity in Bariadi district.

1.7 Organization of the report

The report comprises of six different chapters, chapter one provides the background information about cotton production and productivity at different levels starting with the global level, Africa, country level and the study area level. The chapter also provides information about significance of the proposed study and scope of the study.

Chapter two contains detailed information about cotton production and productivity in Tanzania and proposed study area, it also provides detailed review from various studies by other authors about the proposed study and how production theory is related to the study.

Chapter three is all about methodology of the study, it provides highlights about design of the study, and description of the study area, sampling and sampling techniques, data collection methods applied, the chapter also gives detailed information about data analysis, presentation and adherence of ethical issues in the course of conducting the study.

Chapter four is concerned with data analysis and presentation of the study findings, it gives detailed information about type and analysis conducted as well as various tests on the set hypothesis.

Chapter five gives a detailed discussion regarding the findings of the study; the discussion involves all types of data and analysis for all variables included in the study.

The last chapter (chapter six) provides a summary, conclusions and policy implications from the study, the chapter also indicates limitations of this study, gives various recommendations so as to improve both efficiency and productivity of cotton as well as providing a room for conducting further researches in Bariadi district.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents information and provides critical review from different literature in order to contextualize the problem to be studied under the study. Furthermore, an analysis of various literatures from journals, books, articles, previous studies and different reports is set to focus on analysis of productivity in small scale cotton farms in Bariadi District. The main idea of this review was to find out similarities in findings, contradiction or arguments and recommendations. The review also comprises of theoretical part which offers an insight of the study from the theoretical perspective; empirical literature review presents critical analysis of empirical studies which have been conducted by various authors.

2.2 Definition of key terminologies

2.2.1 Small scale cotton farmers

Minot and Daniels (2002); Toulmin and Gueye, 2003) define small holders farmers in west Africa as cotton producers who cultivate cotton in farms with size ranging between 10 hactres or less. Baffes (2002) defines small scale cotton farmers as those farmers who produce cotton on farms sized between 0.5 to 10 hectares (the average is 1.5 hectares). Based on the experience in the study area, small scale farmers are defined as those who cultivate cotton in farm sizes between 0.5 – 5 acres.

Cotton refers to a soft, fluffy staple fiber that grows in a boll around the seeds of cotton plants. Wilson (2006) characterized cotton as a woody perennial crop, and that the crop is relative more difficult to manage and grow commercially than most food crops, furthermore the crop is susceptible to more kinds of insects, diseases and soil

borne pests. It is a crop that is supposed to be harvested when it is clean, therefore weeds can cause greater damage.

Normally cotton comprises of three primary products from its production which are cotton lint, linters and cottonseed. Cotton lint is utilized in making clothes, shoe strings, pillowcases, denim, towels and different related products. Linters are used in plastics, paper related products, films, yarns and cosmetics. Cottonseed provides three kinds of products when processed; these products are oil, meal and hulls. The oil is the cottonseed's most valuable by-product which is acquired via crushing the cottonseed kernel and the oil obtained is used in cooking, salad dressings, soap, cosmetics and in training of snack meals like chips, crackers and cookies. The hulls are used in livestock feed, fertilizers, fuel and packing materials. The meal is the second most valuable by-product of cottonseed. Meal is made through grinding the cottonseed and is used in farm animals and poultry feed, in addition it is applied as natural fertilizer for farms, gardens and flower beds.

2.2.2 Factors of production

In economics the term factors of production are referred to as inputs that are used in the process of producing goods or services with the objective of making economic profit. In a broader meaning, the factors of production include capital, land, labor and entrepreneurship. These factors of production are also termed as management, machines, materials and labor; furthermore knowledge has recently been talked about as a potential factor of production to be included.

2.2.3 Socio economic factors

Socio-economic factors refer to lifestyle mechanisms and measurements of both financial viability and social standing. These factors directly influence social pleasure and levels of financial independence. Factors such as income, education, health status and environment are usually studied in determining their effects on

human behaviors and circumstances. As lifestyle measurements, they are thought to be directly correlated to patterns of drug use, food choices, migration, disease prevalence and rates of mortality in human populations. In this study the socio economic factors include the farm level and household level factors that are to be studied are not termed as factors of production but rather factors that influence the productivity of cotton.

2.3 Cotton production and productivity overview

Cotton production in the world is practiced by various countries, the main cotton producer countries in the world with their respective cotton production in metric tons are China (6,841,593) which is the world largest producer; India (5,323,467), United states of America (3,598,853), Pakistan (2,216,932), Brazil (1,639,537), Uzbekistan (1,053,742), Australia (976,475) , Turkey (853,831), Argentina (214,371) and Turkmenistan (199,358) (<http://worldknowing.com/top-10-largest-cotton-producing-countries-in-the-world/>).

Cotton sub sector involves various stakeholders who play vital roles in making sure that the crop brings economic value among all stakeholders. TCB, (2010) indicates number of cotton stakeholders involved in cotton production in Tanzania. The first stakeholders are the Cotton Farmers; In Tanzania cotton is grown by approximately 350,000 – 500,000 farmers and mostly small – scale farmers, these farmers determine the volume of cotton production through their decision whether to cultivate cotton, reduce by switching to other crops depending on the situation. The second stakeholder is the Tanzania Cotton Board which was established on July 1, 2004 with the major objectives of regulating, promoting, monitoring, advising, facilitating, coordinating, protecting and representing issues concerning the cotton sector. The third one is Cotton Research Institutes which are responsible for conducting researches related to cotton crop and agriculture development. The fourth stakeholders Tanzania Cotton Association set to articulate and promote the interests of the Cotton Industry Implementation Plan: 2010 – 2015. The fifth one is composed

of Cooperative unions which are currently not well functional; The sixth stakeholders includes Cotton Oil Millers; the seventh stakeholders includes Cotton Spinners, Weavers and Textile Millers which produce exclusively fabrics- khanga and vitenge; dyed drill; linen and bed sheets and utilize only about 20% of domestic lint and the last stakeholders is the government itself through provision of subsidies for procuring cotton inputs and for funding the promotional and regulatory functions.

TCB (2010) indicates that, Tanzania Cotton Board which is the agency responsible for the development of cotton in Tanzania has set its mission in line with its vision and the National 2025 vision. The mission is directed towards promoting high cotton production, productivity and profitability through improved farm management practices; application of appropriate and effective production technologies; domestic maximization of value addition throughout the cotton value chain; effective and sustainable stakeholder organizations; and enhanced self- regulation. Cotton production and productivity in Tanzania were 685,000 bales of seed cotton equivalent to 126,000 Metric Tons of lint cotton and 750 kg/ ha of seed cotton equivalent to 260 kg/ha of lint respectively in 2008/09.

2.4 Theoretical framework

2.4.1 Production theory

Production involves transformation of factors of production known as inputs to get outputs. Inputs, on one hand include things which a firm employs for use in its production process. An output, on the other hand, is the result that comes out of a production process. In other words, production theory explains the relationship between inputs and outputs, which is the transformation of factor inputs into products. Rationale of the production theory in this study comes in the way factors of cotton production (inputs) such as seed quantity, pesticides quantity and land (farm size) affect cotton production. It is also explained by the inclusion of the socio economic factors such as age, family size, sex, years of schooling (education),

households' income, farming experience, cultivation cost, marital status and access to extension services influencing cotton productivity (efficiency) in cotton to small scale cotton farmers in Bariadi district.

2.4.2 Production function

A production function is a mathematical calculation which shows the level of output that can be produced from a given combination of inputs. The function gives a link to the levels of inputs used and attainable levels of outputs. The general form of production function is given by $Q = f(L, K)$ where Q stands for the quantity of output, L stands for the quantity of labor used, and K stands for the quantity of capital employed in the production process. This expression provides information to us that the maximum quantity of output the firm can get depends on the quantities of labor and capital it employs. There could be more other categories of inputs, but labor and capital tend to be the more important ones. The general form also specifies that production (output) of a given commodity depends on specific set of inputs. In more specific form, the production function presents the quantitative relationships between inputs and outputs that means Output is a function of capital (K) and labour force (L). The production function can take the form of a schedule, a graph line or a curve, an algebraic equation or a mathematical model.

Besanko and Braeutigam, (2012) defines inputs as resources, such as labor, capital equipment, and raw materials that are combined to produce finished goods. They also define factors of production as resources that are used to produce a good and Output the amount of a good or service produced by a firm.

In this study, the production function is explained mathematically in the following form $Y = f(K, L)$, where Y refers to cotton output level and $f(K, L)$ refers to function of inputs which are socio economic factors. It aims at assessing the underlying relationship between inputs and output in cotton production. The study also assessed the significance of the influence of the inputs to production of cotton. In this study

inputs are referred to socio-economic factors and farm specific factors and output being cotton production. This study was focused on identifying the inputs of cotton production are identified and clearly analyzed so that appropriate measures may be suggested with the aim of increasing outputs in the cotton production. Therefore in this perspective, the inputs were independently related to cotton production (output) so as to assess the significance of their influence on technical efficiency of cotton productivity to small scale farmers in the study area.

2.4.3 The concept of productivity

Productivity is the economic term that describes a measure of output per unit of input. Hanumanthappa, (2014) defines agricultural productivity as the ratio of the index of total agricultural output to the index of total input used in farm production. It is a measure of the efficiency with which inputs are utilized in the production process while keeping other things equal. Coelli *et al.* (2005) defines productivity of a firm as the ratio of output(s) that it produces to the ratio of inputs that it uses in the production process, there are two ways of determining productivity, the first one is partial productivity which is obtained by using a single input and single output for instance labour productivity in a factory, fuel productivity in power stations and land productivity in farms; the second type of productivity is total factor productivity that combine all factors of production to obtain the single index of input that will be used to obtain the ratio measure of productivity.

2.4.4 Efficiency

Efficiency of a firm is referred to as the actual productivity of a firm relative to a Maximal potential productivity. It is a comparison of what is actually produced or performed with what can be achieved with the same resources utilization. Coelli *et al.* (2005) categorizes efficiency as allocative efficiency (AE), technical efficiency (TE) and economic efficiency (EE). Allocative efficiency involves combination of inputs such as labor and capital that produces a given level of output at minimum

cost, a firm is regarded as allocative inefficient when the combination of factors of production are used in proportion that does not minimize the cost of producing a given level of output. Technical efficiency is referred to a situation whereby a firm can produce a maximum level of output from a given combination of inputs. Technical efficiency of a farm or firm can be calculated with an output orientation method as the ratio of actual (observed) output relative to the potential (maximum feasible) output: Economic efficiency is the combination of both allocative efficiency and Technical efficiency in the production process, which means if a firm or farm is both Technical efficient and allocative efficient is termed as economic efficient.

2.4.4.1 Measurement of technical efficiency

Abedullah *et al.* (2006) indicates that technical efficiency can be estimated by using different approaches and these may include the stochastic frontier (parametric approach) and data envelopment analysis (DEA), also known as non-parametric approach.

Berger and Humphrey (1997) identified (DEA), free disposal hull (FDH) as methods for non-parametric analysis and stochastic frontier approach (SFA) and distribution free approach (DFA) as parametric methods of identifying technical efficiency, these two last approaches are referred to as econometric frontier approach and they specify the functional forms of the cost function, profit function, or production function in relationship to inputs, outputs, and environmental factors, and it allows for random errors.

Kibaara (2005) defines technical efficiency of a farm as the ratio of the observed output to the corresponding frontier output, conditional on the level of inputs used by the farm. Therefore, the value of technical efficiency is can be defined as the amount by which the level of production for the farm is less than the frontier output. Technical efficiency functions can be classified as parametric and non-parametric linear programming approaches. The non-parametric approach consists of DEA and

the FDH whereas the parametric approach consists of the SFA, TFA and the DFA. Both approaches differ based on the assumptions made about the functional form, whether random errors have been accounted for, and the probability distribution assumed for the inefficiency. Deterministic models assume that any deviation from the frontier function is due to inefficiency, meaning that they are very sensitive to outliers (Thiam *et al.* 2001). Nevertheless, there is no common agreement among researchers about the best method for measuring efficiency.

This study employed a stochastic frontier analysis (SFA) method in the Cobb-Douglas production function. Aiger, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977) independently proposed the stochastic production function model which was in the following form:

$$\ln q_i = X_i' \beta + V_i - U_i \dots \dots \dots (1)$$

Source: Coell et al (2005)

Whereby q_i = output of the i -th firm

X_i = $K \times 1$ vector containing logarithms of inputs

β = vector of unknown parameters

V_i = symmetric random error

U_i = non negative random variable associated with technical inefficiency

In most cases the Stochastic Frontier Analysis is directed towards predicting the effects of inefficiency and therefore technical efficiency in the study area was computed by using the common output oriented measure of technical efficiency which is given by the ratio of firm's output to the corresponding stochastic frontier output. Before estimating the technical efficiency of a firm, the parameters of the stochastic frontier in the equation 1 above were estimated and then the technical efficiency was predicted thereafter. Coell *et al.* (2005) underscored that the value of technical efficiency ranges between zero and one. When TE equals 1 means the

farmer produces with fully technical efficiency, when $TE < 1$ means the farmer is not making the most, out of the inputs used (Ilembo and Kuzilwa, 2014).

2.4.5 Theoretical prediction of variables

Theoretical prediction of the variables that were employed in the study refers to the anticipated effects of the variable on cotton productivity. By considering the variables to be used in assessing the level of productivity in the study area, the prediction of the variables was as follows; (socio economic factors) such as age was predicted to have positive effects on cotton production that means as age of respondent increases within the productive range it increases the level of cotton production ; family size (with more economically active members) was predicted to have positive effects on cotton production through provision of family labour that is applied in various aspect like cultivation, weeding and harvesting ;marital status was predicted to have positive effects on cotton production by increasing labour on farms; education level of farmer was predicted to have positive effects on cotton production since educated farmers tend to apply more modern agricultural practices than those who are not educated ; households' income was predicted to affect cotton production positively since farmers use their incomes in supporting activities related to cotton cultivation of their farms; farming experience was predicted to have positive effects since the farming experience goes together with increasing farmers' solving problems ability related to cotton production; Cultivation cost was predicted to have positive effects due to the fact that cultivation cost increases with farm sizes, pesticides quantity applied was expected to have positive effect and seed quantity was predicted to have positive effects on cotton production. Farmer's sex was expected to have positive effects to males since cotton cultivation is a more labour intensive activity and cash crop mostly preferred by males, cultivation cost was expected to have positive effects on cotton output since cultivation cost increases with unit area which also has positive effects on the level of cotton output and extension service was predicted to have positive effects on cotton production.

2.5 Empirical review

In identification of socio economic factors that affect efficiency of cotton production in Bariadi district, it is important to get the similarities, contradictions or arguments and recommendations of previous conducted studies in related study, which in turn provided a gap that justified the essence of conducting this study.

2.5.1 Factors effecting efficiency and production

A study by Chisanga *et al.* (2016) investigated different sources of technical efficiency as well as the impact of technical efficiency on the welfare of cotton farmers in Zambia by using the Data Envelopment Analysis (DEA) and then supplemented by the Stochastic Frontier Approach (SFA). It was found that Zambian cotton farmers are less efficient compared to farmers in other countries, their technical efficiency average 43% and only 20 percent of the cotton farmers produce at 50 % or above.

Odedukun *et al.* (2015) conducted a study on Parametric Estimation of Allocative Efficiency among cotton farmers in Zamfara State, Nigeria which determined the level of cost incurred, estimation of the levels of allocative efficiency among cotton farmers and examining the factors affecting allocative inefficiency. The study findings showed that allocative efficiency score was 0.64 which implied that farmers in the study area could still maximize the utilization of inputs and increase their production frontier by 36%. It was further noted that factors like age, major occupation, access to credit and extension contact had influence in increasing allocative efficiency of cotton farmers, and the study recommended that government should support farmers through timely provision of inputs required in cotton production at affordable prices, provide adequate credit facilities, adoption to improved technologies and increase extension service to farmers.

Another study by Odedukun *et al.* (2015) conducted an evaluation on parametric technique of technical efficiency measurement to smallholder cotton farmers in Nigeria and the study aimed at estimating the level of technical efficiency, inputs and output relationship as well as determining elasticity and returns to scale in cotton production. Among other findings the study revealed that the average technical efficiency score was 0.67 implying that farmers could still maximize the utilization of inputs and increase their production frontier by 33%.

A study by Atala *et al.* (2015) used descriptive statistics and net farm income model as analytical tool and found that input utilization, production technologies, socio economic factors like age, education, sex, marital status and farming experiences have effects on cotton production. Analysis of net farm income, returns to investment and returns per man day gave different profit levels. It was recommended that appropriate inputs delivery network need to be put in place by government and agro-service agencies, adequate and intensive research and extension service delivery programme should track a consistent and systematic campaign for cotton production while an enabling marketing policy should be instituted by government through product marketing corporation which will serve as a clearing house for cotton marketing in Nigeria.

Ilembo and Kuzilwa (2014) conducted a study on Technical Efficiency Analysis of Tobacco Production in Tanzania by using stochastic frontier analysis (SFA) method in the Cobb-Douglas production function. Technical efficiency was found to be 64.7% and that the variables of farm size, input credit use, off- farm income and education had negative influence on technical inefficiency but only age of household head showed a positive relationship with inefficiency.

Karimov (2014) investigated factors affecting efficiency of cotton farmers in Uzbekistan and it was found that farmers' educational level, farm size, water availability, application of manure, access to formal credit, water services from Water User Association's, farmers' participation in off-farm work and poor drainage

systems, contributed significantly to input use efficiency. It was further identified that the impact of agricultural experience on technical efficiency was positive although it was not significant.

Kidane *et al.* (2013) conducted a study on Agricultural Inputs and Efficiency in Tanzania Small Scale Agriculture by comparing efficiencies of tobacco with maize, groundnuts and rice by using Frontier Production Approach and the efficiencies were found to be 75.3%, 68.5%, 64.5% and 46.5% for tobacco, maize, groundnuts and rice respectively.

Musemwa *et al.* (2013) applied a Tobit model censored at zero to examine factors that explained differences in production efficiency among resettled farmers in Zambia. Efficiency scores were obtained through the use of Data Envelope Analysis (DEA) whereby allocative efficiency was found to be influenced by good production knowledge, farm size, arable land and area under cultivation whereas economic efficiency was influenced by secondary education, household size, farm size, cultivated area and arable land owned.

Another study by Alam *et al.* (2013) analyzed data using descriptive statistics and budgetary techniques. The result of the socio-economic characteristics such as age, sex of farmer, education level and farming experience had significant influence on cotton production. The study also identified low price of seed cotton, pest and diseases infestation, inadequate funds, highest cost of inputs and inadequate extension agents as constraints of production. The researchers recommended that farmers should form cooperative societies to have access to loans; they should also be trained by Government and Non-Governmental organization on the effective method of pesticide application in the study area.

Chiona (2011) investigated technical and allocative efficiency of smallholder maize farmers in Zambia through the use of non-parametric approach of Data Envelope Analysis. It was found that the level of technical efficiency scores ranged from

0.0005 to 1 with the average technical efficiency stands of 15 percent and only 0.23 percent of the farmers being were efficient. Allocative efficiency averaged at 12 percent with only 0.27 percent of the farmers being efficient.

Olarinde (2011) investigated technical efficiency differentials and their determinants among maize farmers in Nigeria. The study employed a total sample of 300 maize farmers from Oyo and Kebbi States. The study's data were analysed through the use of descriptive statistical methods and by applying a Trans log frontier production function. It was found that, sampled farmers were technically inefficient with the mean technical efficient of about 56% and 57 in Oyo and Kebbi states respectively. The main determinants of technical efficiency in these states were extension services and farm distance, farming experience, credit accessibility, number of other crops grown and rainfall (precipitation).

Ashfaq *et al.* (2011) conducted a study that examined the resource use efficiency of small Bt cotton farmers of Punjab province of Pakistan using the production function approach. Data for the study were obtained from 150 randomly selected Bt cotton farmers from Punjab province using a multistage sampling procedure and then categorized into small, medium and large farmers. Average farm size of small farmer was found to be 5 acres. Regression results indicated that fertilizer, number of spraying pesticides, irrigation and labour cost were significantly affecting Bt cotton production while farm size was found to be non-significant.

Gul *et al.* (2009) investigated technical efficiency of cotton farms in Çukurova region in Turkey. The study employed cross sectional data and technical efficiency of cotton farms was estimated by using the Data Envelopment Analysis (DEA) and technical efficiency scores were calculated employing an input oriented DEA. The study also used Tobit regression analysis in identifying determinants of technical efficiency. It was found that cotton farmers can save inputs by at least 20% while remaining at the same production level, which means famers can improve their technical efficiency by 20% by using the same level of inputs combination. Ages of respondent and

education level of cotton growers are the variables that were found to have strong effect on technical efficiency level of the farmers.

Anwary (2009) examined factors affecting cotton production in Multan region using primary source of data. The study employed Cobb-Douglas Production Function to assess the effects of various inputs like cultivation, seed and sowing, irrigation, fertilizer, plant protection, inter-culturing / hoeing and labour cost on cotton yield. The results revealed that the coefficients for cultivation (0.113) and seed (0.103) were found statistically significant at 1 percent level. This study recommended that there is a need to ensure the availability of these scarce inputs by both public and private sectors as these inputs were major requirement of the cotton crop.

Asif *et al.* (2005) employed Cobb Douglas type production to assess the effects of education, land preparation, seed, and irrigation. This study employed a regression equation which was estimated assuming a modified Cobb-Douglas type production and verified that education, plant protection measures, fertilizer and land preparation were contributing towards higher cotton yield on the sampled respondents' farms. In this study, some important factors were taken into account to determine their effect on cotton productivity. These important factors were schooling years of the respondents, land preparation, irrigation, seed rate, plant protection measures and fertilizer nutrients. All these factors were found positively contributing towards higher yield of cotton crop in Sargodha district. However, the effects of schooling year, land preparation, fertilizer and plant protection measures were significant.

2.6 Summary of empirical review

This part provides a summary of selected reviewed studies through the caption of key objectives, methodology, dependent variable applied, and Independent variables applied and key findings obtained in a particular study. See table 2.1 below:

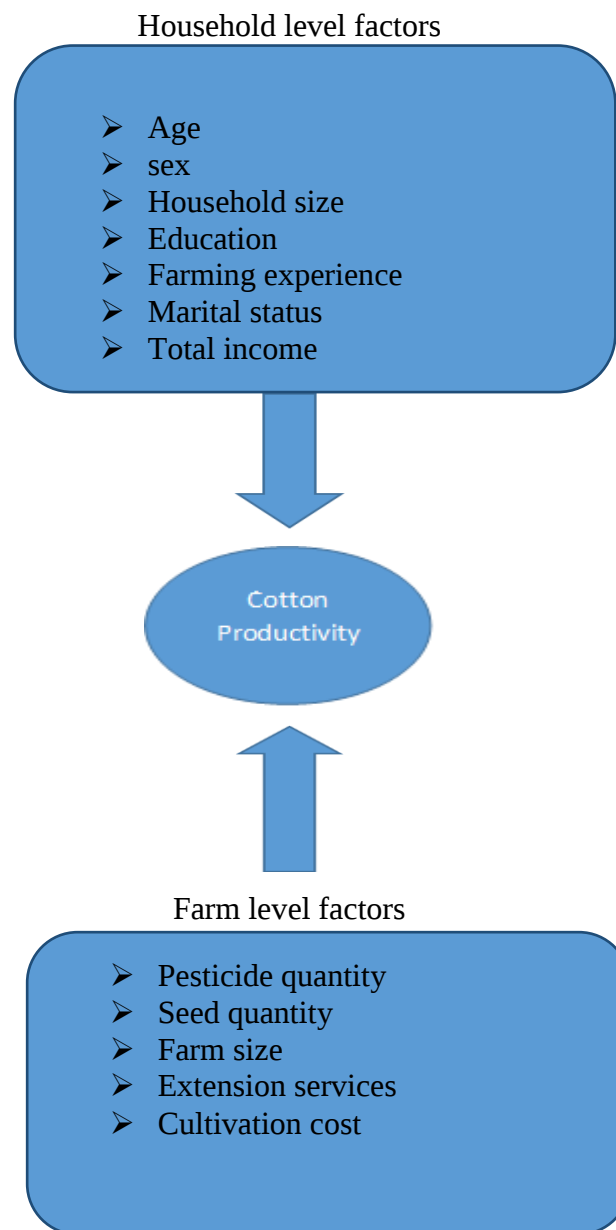
Table 2.1: Summary of empirical review

Reviewed study	Objective	Methodology	Dependent variable	Independent variables	Key findings
Odedukun et al (2015)	To determine the level of cost incurred, estimation of the levels of allocative efficiency and examining the factors affecting allocative inefficiency	Descriptive statistics and stochastic frontier cost function models.	Cotton production	Cost of land ,Cost of seed , Cost of fertilizers ,Cost of family labour, Cost of hired labour and Cost of agro-chemicals	The average Allocative efficiency score was 0.64. seed cost, agro-chemicals cost, family labour and hired labour were positively related to cotton production
Gul et al (2009)	To examine technical efficiency of cotton farms	Cross sectional data, DEA and Tobit regression model	technical efficiency of cotton farms	Farmer age , Experience , Cotton area groups, Number of parcels, Education level	Age, education level and groups of cotton growing areas had strongly effect on efficiency level of the farmers.'
Odedukun et al (2015)	estimating the level of technical efficiency, inputs and output relationship as well as determining elasticity and returns to scale in cotton production	The Stochastic Frontier Approach (SFA) and the production function of Cobb-Douglas form.	Cotton productivity	Farm size, Seed , Family labour, Hired labour, Fertilizer and agro-chemicals	technical efficiency score was 0.67, all factors were positive related to cotton production except for family labour and hired labour which were negative
Atala et al (2015)	Describing socio-economic characteristics, resource utilization and production technologies and to determine profit in cotton production.	descriptive statistics and net farm income model	Cotton production	major occupation, age , level of education, marital status, gender, experience in farming, household composition and access to credit	age, education, sex, marital status and farming experiences have effects on cotton production
Alam et al (2013)	Conducting economic analysis of cotton production	descriptive statistics and budgetary techniques (gross margin)	Cotton production	Age, sex, family size, education level, farming experience and farm size	age, sex of farmer, education level and farming experience had significant influence on cotton production

2.7 Conceptual framework

Based on the reviewed literature different factors have been identified to have effects on cotton productivity. such factors are age, household size , years of schooling (education) , households' income, farming experience, marital status, seed cost, farm preparation cost, irrigation cost, farm protection cost, cost of fertilizers, farmers sex, cultivation cost, seed cost, pesticides cost and extension services. The conceptual framework indicates a conceptual link between the dependent and independent variables. In this study cotton production as a dependent variable was linked conceptually with the independent variables which are socio economic factors included in this study. These factors are age, household size , years of schooling (education) , households' income, farming experience, farm size, farmers sex, cultivation cost, seed cost, farm cultivation cost and extension services. The conceptual relation of this study is summarized in the figure 2.1 below:

Figure 2.1 Conceptual framework



Source: Researcher's own construction

From the figure (2.7.1), cotton productivity (output) is the dependent variable while the independent variables compose of socio-economic factors. Therefore, this relation can be briefly explained as follows from the figure.

Cotton productivity: This was conceptualized as the dependent variable and related with various independent variables; the existence of the relationship between them was tested based on the set hypothesis. The cotton yields of small scale farmers in this case was termed as the dependent variable whereas some selected socio economic factors which had been related to have effects on cotton yield were related as independent variables of the farmers in the study area.

Household level factors: This comprises the independent variables such as; age, sex, schooling years (education level), farming experience, marital status, total income and family size which will be related to the level of cotton production so as to determine their impact on the level of cotton production.

Farm level factors: This comprises the independent variables such as farm size, cultivation cost, Quantity of seed applied, quantity of pesticides applied and access to extension services.

Age of respondent

According to United republic of Tanzania report (URT) of 2013, age of respondent is defined as the number of years one had lived as at last birthday by making reference to the census night. Alam *et al.* (2013) found the average age of farmers to be 32, that means younger people dominated in cotton production, this dominance could be due to the labour intensive nature of cotton production, and thus require young people who are energetic, more agile, aggressive and capable of making good production decision and have more influence on productivity than older farmers.

Household size

URT, (2013) defines household size as a number of person or group of persons who reside in the same homestead or compound but not necessarily in the same dwelling unit, they have same cooking arrangements, and are answerable to the same household head. Atala *et al.* (2015) defines household size as household composition which is composition depicts the number of persons in a family living together in a house. This factor was related with the dependent variable (productivity) by providing more labour in terms of cultivation, weeding, planting, applying pesticides and other related activities especially to farmers who depend more on family labour in increasing their productivity.

Schooling years (education level)

UNESCO (2011) defines education level as education programmes that can be grouped into an ordered series of categories which represent broad steps of educational progression in terms of the complexity of educational content. That means the more advanced the programme, the higher the level of education. It can also be expressed in terms of number of years taken on reaching a particular education level. This factor was related with the dependent variable through increasing the ability of solving problems related to farms as well as acquiring and applying the knowledge of modern agricultural practices. Asif *et al.* (2005) found that education plays a vital role in the adoption of improved technology and attaining higher productivity level. The more educated farmers manage various farm practices in a better way as compared to less educated farmers and they learn easily about new development and innovation concerning production technology of crops. Furthermore, they have the advantage to understand about prevailing marketing situation at local and national level regarding farm inputs and outputs.

Farmers' total income

Farmers' total income is referred to as the combined gross revenue of the farmer from various sources. It consists of every kind of earnings together with salaries, wages, retirement income, government transfers and gains from investment. Farmers' total income was related to cotton productivity through determining the size of farms to be cultivated especially when land is hired, acquisition of farm implements which also have effects on the level of cotton production, therefore household's income has influence on the productivity of cotton.

Farming experience

Farming experience is defined as the know-how that a person gains while working in a farm. It provides many benefits such as giving skills and knowledge to improve farmers potential and eventually helps in improving agricultural performances. Alam *et al.* (2013) indicates that, greater number of the farmers in their study who had more farming experience improved their cotton output. According to the study farming experience implies that majority of farmers have been in the farming business for a long time and are therefore conversant with the problems of cotton production in the area. Atala *et al.* (2015) depicts that year of farming experience increased agricultural productivity among farming households in Nigeria.

Farmers' sex

Sex is defined as the state of being male or female, in research this is one of the factors that are termed as dummy variables, and it is normally denoted by number 1 and 0 that means if a farmer is female then is represented by 1 and if the farmer is male then is represented by 0 and vice versa. Alam *et al.* (2013) indicated males dominate cotton production by 88%, Atala *et al.* (2015) indicated that male dominate by 90%, this tells us that female involvement in cotton production from these studies was only 12% and 10% respectively. The male dominance could be due

to the nature of cotton production, which is a labour intensive crop and as a cash crop preferably interesting more males than females.

Pesticides cost and quantity

Pesticides cost is referred to as cost incurred on acquiring and applying pesticides meant for destroying pests. The most important function of the pesticides to plants is protection products against harmful influences such as weeds, fungi, or insects. Shao, (2002) indicates that, pesticides come in two forms: oil based and water based. Oil based pesticides are of a variety of brand names and are sold by private suppliers for with the price ranging between 3,500 -5,000/- per liter, enough for spraying one acre once. The water based pesticide (Decis 250 ml) is supplied by the Cotton Development Fund, and sold for 6,000/- and is enough for spraying two acres once. Therefore to apply pesticides to one acre for the six recommended times would cost the farmer approximately 21,000/- to 30,000/- for the oil based pesticides or 18,000/- for the water based Pesticides. Pesticides quantity is the amount of pesticides that are applied on the cotton plants for the purpose of controlling pests. Farmers in the study area used different quantities of pesticides.

Seed Quantity

Chaudhry, (1995) explained that, together with land rent, weeding, fertilizers, irrigation, insecticides and harvesting, seed quantity and cost are important to be taken into account for calculating per hectare and per kg cost of seed cotton. In this study it indicated that the cost of growing and harvesting one hectare of seed cotton was about US\$ 2,000 in Israel and Spain countries. In the Latin American region it was estimated to cost almost US\$ 1,300 to grow and harvest one hectare of seed cotton in Colombia, Mexico and Peru whereas in countries like Chad, Côte d'Ivoire, some part of rain fed cotton in South Africa, Vietnam and Zimbabwe it was estimated to cost more than US\$ 300 to grow and harvest one hectare of seed cotton. Production cost for one hectare of seed cotton in Australia, in other countries like

Brazil, China and Pakistan the cost ranges between US\$ 650 and US\$ 775. However in Turkey more than US\$ 1,000 are spent to produce a hectare of cotton.

Cultivation cost

Cultivation cost is referred to as the cost incurred through the action of tilling the ground by hoeing or ploughing before planting the seeds. Anwary (2009) reveals that the coefficient for the variable of cultivation cost was 0.113 showing the positive relation between cotton yields and the cost of cultivation. This implies that cotton yield value per acre increased by 11.3 percent in response to a percentage increase of cultivation cost and therefore the variable was found highly significant indicating the strong impact on cotton yield.

Extension services

Extension services refer to number of visits the extension agent makes to the farmer with the aim of providing advice concerning agricultural matters. Sodjinou *et al.* (2015) highlighted that with respect to support from extension services, the number of visits made by the extension agents is positively and significantly associated with the adoption of organic cotton farming. Organic cotton farmers benefit from serious extension services from NGOs and development organizations, which are the major drivers of organic value chains in Benin and in West Africa in general.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The main objective of this chapter is to present a general description of different methods that were employed during conduction of the research. The chapter is divided into the following sections: research design, study area, sampling techniques, data collection techniques, data entry and management, model specification and data analysis. This chapter has also taken into consideration advantages and disadvantages of the analysis method that have been applied.

3.2 Research design

According to Kothari (2004), research design is defined as the arrangement of conditions for collection and analysis of data in a manner that aims at combining relevance to the research purpose with economy in procedure. In fact, the research design is the conceptual structure within which research is conducted; it constitutes the blueprint for the collection, measurement and analysis of data. As such the design includes an outline of what the researcher will do from writing the hypothesis and its operational implications to the final analysis of data.

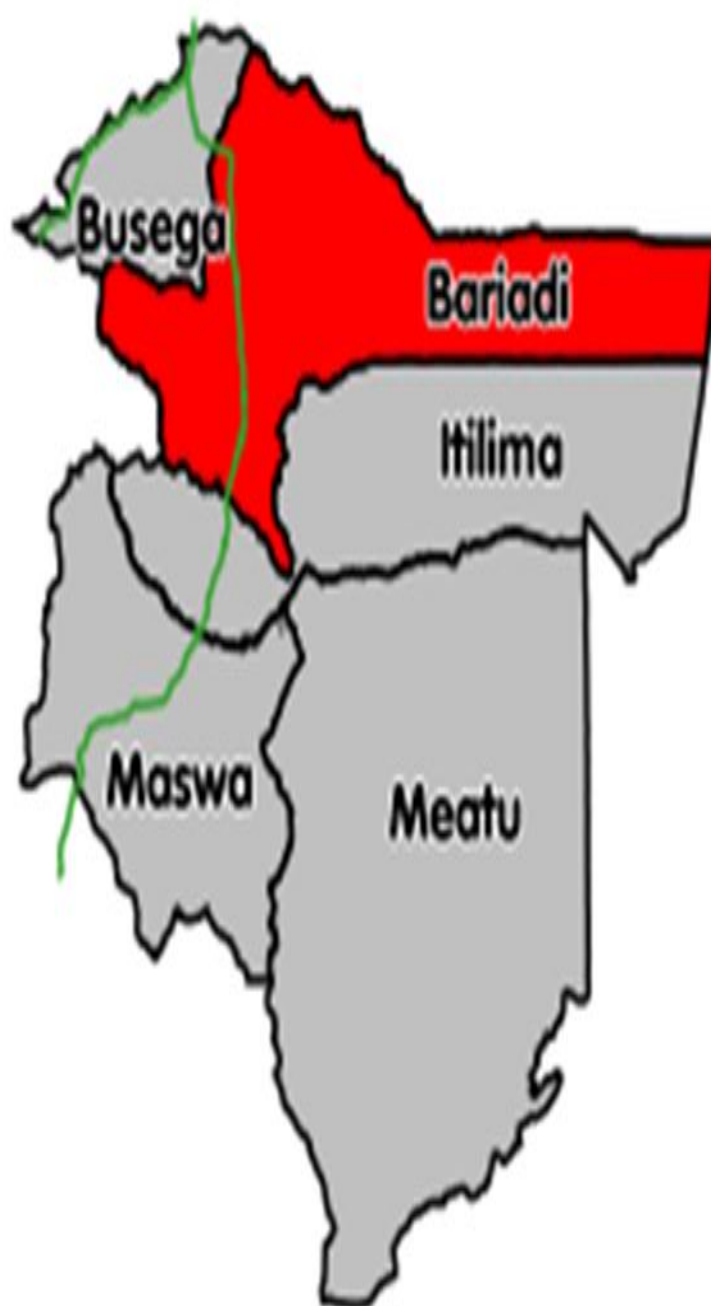
The analysis of productivity in small scale cotton farms in Bariadi District, Tanzania was conducted using cross sectional survey by employing primary data covering the period of 2015/2016 season. This is the kind of design whereby all the measurements for sample members are obtained once, cross sectional survey design was chosen for this study due to the fact that it has some advantages such as quick and easy in obtaining data, the design is also cheap and easy to perform.

3.3 Study area description

The study was based at Bariadi district found in Simiyu region in Tanzania and aimed on conducting a productivity analysis of small scale cotton farmers. Bariadi district is one of the five districts in Simiyu region, it is located North of Tanzania and South East of Lake Victoria and lies between Latitude $2^{\circ}15''$ and $3^{\circ}10'$ South of Equator and longitude $33^{\circ}40''$ and $35^{\circ}10''$ East of Greenwich.

The district is bordered by Busega Districts (Simiyu Regions) to the West, Bunda and Serengeti Districts (Mara Region) to the North, Maswa Game Reserve to the East, Maswa and Itilima Districts (Simiyu Region) to the South. The district has an area of 5,967.92 km² with a total population of about 422,916 comprising 201,718 males and 221,198 females (National Census, 2012). The study area has been chosen due to fact that it is endowed in agricultural potentials and in particular it is one among the district in Tanzania with high level of cotton production, TCB (2010).

Figure 3.1: Bariadi district map



The district is characterized by the annual rainfall that ranges from 700mm-950mm pa. There are two periods of rain seasons. The short rain period is normally between October – December with a dry spell in January and February. Long rain falls in between March to mid-May. The period from June to September is hot and dry. The average temperature during the day is 29⁰C and 19⁰C at night.

3.4 Target population

Target population is defined the whole organization of individuals or items to which a researcher gets interest in generalizing the conclusions. The target population usually has varying characteristics and it is also known as the theoretical population. In the context of this study, target population involved small scale cotton farmers who had grown cotton in the 2015/2016 season.

3.5 Sample population and sampling techniques

Sample population is the proportion or subgroup of a population that is selected from a population for the purpose of analysis and it is from this sample population generalizations are made based on an analysis. In the context of this study the sample population was a portion of small scale cotton farmers which was used to represent the entire group.

3.5.1 Sample size

According to Kothari (2004), sample size is defined as the number of items to be selected from the universe to constitute a sample. The sample size was obtained by using the formula developed by Yamane (1967) as it can be seen in the equation (2) below:-

$$n = \frac{N}{1 + N(e)^2} \dots\dots\dots(2)$$

Where;

n=sample size

N=Total number of respondents

e=standard error

By considering the total number of respondents of household cultivated cotton in the 2015/2016 season which is 18,300, and standard error of 0.08798, the sample size was calculated as follows:

$$n = \frac{N}{1 + N(e)^2}$$

$$n = \frac{18,300}{1 + 18,300(0.08798)^2}$$

$$n = 128.285 \approx 128$$

Therefore basing on the result obtained using the formula above, the sample size that was taken into consideration in this study involved 128 small scale cotton farmers, this sample size is manageable taking into consideration time and budget constraints, and it is also supported by Sekaran (2003) who postulates that the sample size for social science studies with number observations ranging between 30 and 500 is acceptable. Also based on the number of variables and the type of data employed in this study, the sample size proposed is sufficient.

3.5.2 Sampling techniques

Kothari (2004) defines a sample design as a definite plan that is used for obtaining a sample from a given population. It additionally refers back to the technique or the process the researcher might adopt in choosing objects for the sample. Sample design can as well determine the sample size to be employed. Webster (1985) defines

Sampling as the act, system, or method that is used in deciding on a suitable sample, or a representative a part of a population for the reason of determining parameters or characteristics of the whole population. Both probabilistic and non-probabilistic sampling were employed in this study .Non probabilistic sampling was applied when establishing a sample frame. Bariadi district comprises of 4 divisions and 25 wards, 3 wards do not cultivate cotton therefore the purposive sampling was applied by choosing only two wards among wards that cultivate cotton from each division. Simple random sampling was then applied in obtaining 16 respondents from the 8 selected wards making a total of 128 respondents. This number of respondent was sufficient to represent the population to be studied.

3.6 Methods of data collection

3.6.1 Types of data and collection instruments

This study used primary data collected from small scale cotton producers from various wards in Bariadi district by using the structured self-administered questionnaires which consisted of both open ended and closed ended questions, questionnaires as instrument for data collection in this study were used by the researcher based on their merits and demerits. Questionnaires enables collection of data at relative low cost , less time consumption, less bias on representation of sample, ensuring confidentiality of information and data can be collected easily from a large sample. Despite the fact that questionnaires have various advantages, they have also some disadvantages such as low response rate, deprival of the possibility of asking question or request for some clarification and absence of direct contact between the respondent filling the questionnaire and the interviewer.

On ensuring that the questions set in the questionnaires are answered as they were intended, the questions were kept short and simple, without ambiguous words or phrases and thereafter pretesting was done to a small group of respondent in order to

assess general understanding of the questions, to refine the questionnaire and make possible amendments to the questions.

3.6.1.1 Data entry and management

Data entry and management was done by using SPSS and EXCEL software, this is due to the fact that SPSS and EXCEL are suitable software for data entry and management.

3.7 Variables description and measurement

Variable description and measurement consists of the notation of the variable using a symbol or abbreviation, name of the variable, definition of the variable and its measurement as indicated in table 3.1 below:-

Table 3.1 variable description measurement

Variable	Name of variable	Definition of variable	Measurement
Y	cotton yield	Cotton output resulting from combination of various inputs	kilograms harvested
ED	Education	Education level of respondent	Std VII, 1=yes, No =0 Form IV, 1=yes, No=0 Form VI,1= yes, No=0 Certificate,1=yes, No=0 Diploma, 1=yes, No=0 and Degree, 1= yes, No=0
HI	Farmers total income	Income earned by the farmer	Tshs
FE	Farming experience	Experience obtained by the respondent on cotton farming	Number of years spent in cotton farming
CC	Cultivation cost	Cost incurred on cultivating the land before cotton planting	Tshs
PQ	Pesticide quantity	Number of litres incurred in application of pesticides	Litre
SQ	Seed quantity	Amount of cotton seed planted	Number of kilograms
E	Extension service	Extension services provided to the farmer	Accessed, 1 Not accessed, 0
A	Age	Age of respondent	Number of years lived by the respondent
HS	Household size	Number of household members of the respondent	Number of household members
S	Sex	Sex of respondent	1= male, 0= female
FS	Farm size	Size of farm cultivated by the farmer	Acre
MS	Marital status	Marital status of the farmer	single, 1=yes, No =0 married, 1=yes, No=0 divorced,1= yes, No=0 separated,1=yes, No=0 widow(er), 1=yes, No=0

3.7.1 Dependent variable

The dependent variable applied in this study is cotton productivity that was conceptually linked with some of selected socio economic factors termed as independent variables.

3.7.2 Independent variables

Independent variables are those variable which influence the dependent variable, in this study the researcher included household level and farm level (socio economic variables) such as age of respondent, household size, education level, households 'total income, households' income, farming experience, farm size, marital status, farmers sex, cultivation cost, seed quantity, pesticides quantity and extension services.

3.8 Data presentation and analysis

3.8.1 Introduction

The essence of data presentation and analysis was to help the researcher to provide interpretation about what was collected from the field. The process involved data coding, data editing and analysis to be in a meaningful sense.

3.8.2 Data analysis

Data analysis in the study involved both qualitative and quantitative data collected. The analysis based on two types of analysis which are descriptive statistics and inferential statistics and employed Stata and SPSS software. Descriptive statistics involved different measures such as frequencies, percentages, means and standard deviations. Inferential statistics was conducted by using the Stochastic Frontier Model.

3.8.2.1 Data processing

Kothari, (2004) provides the meaning of data processing as preparing data for analysis and that it includes editing, coding, classification, tabulation and using percentages. This process had two stages which were data cleaning and data reduction. The process included detecting for abnormalities, errors, omission, accuracy and consistent answering of the questions. In order to reduce the quantity of data, some numeric and symbols were assigned to reduce the responses into few categories or classes with common characteristics. Thereafter tabulation and graphs were used to summarize raw data and then displayed for further interpretation.

3.8.2.2 Econometric model specification and hypothesis

Model specification refers to the determined relationship between variables (independent and dependent) in the model. It tells which independent variables should be included in or excluded from a regression equation. In general, model specification of a regression model is supposed to the theoretical considerations rather than empirical or methodological ones. The researcher in this study applied a two-step procedure to analyze productivity and Technical efficiency of small scale cotton farmers in Bariadi. The first phase involved measuring technical efficiency of farmers and the second phase examined how socio economic factors influence technical efficiency of small scale cotton farmers in the study area.

This study applied a stochastic frontier production function and inefficiency model to analyze the influence of socio economic effects on technical efficiency of smallholder to farmers in Bariadi district. The inefficiency model is derived from the error component of the stochastic frontier model. The model used different socio economic variables which were predicted to have different effects on technical efficiency.

First stage of the Study employed Stochastic Frontier Approach (SFA) method in calculating the Technical Efficiency of cotton farmers. Aiger, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977) independently proposed the stochastic production function model that makes assumptions about the data, also the SFA method has been chosen in the study based on its ability to distinguish the error term between the two sources: the random error term that represents the inefficiency component and the effects of factors beyond the control of the farmer and the random error term that represents the inefficiency due to farm or farmer , Battese and Coelli (1995); The specific form of the Cobb Douglas stochastic production frontier function was expressed as follows :-

$$\ln Q_i = \ln \beta_0 + \beta_1 \ln PQ + \beta_2 \ln SQ + \beta_3 \ln FS + v_i - u_i \dots\dots\dots(3)$$

Whereby Q_i = cotton output of the i-th farmer in Kg

PQ= pesticide quantities in litres

SQ= Seed quantity in kg

FS= farm size of cotton in acres

β_i = vector of unknown parameters to be estimated

V_i = the symmetric component of the error term, associated with random factors which is not under the control of the farmer.

U_i = the non-negative random variable under the control of the farmer

Ln = Natural logarithm

Therefore in the study area, the empirical model used by the researcher to estimate Technical efficiency was the Cobb Douglas production function as supported by Coell *et al.* (2005) indicating that the Cobb-Douglas and Translog models overwhelmingly play a major role in the applications of most stochastic frontier and econometric inefficiency estimations. In particular the Cobb Douglas production was preferred to Translog due to the fact that it is frequently applied in estimation of farm efficiency based on its advantages in computation and interpretation, The function also has the advantage of its capability in handling multiple inputs in the generalised

function and handling various econometric estimation problems like serial correlation, heteroscedasticity and multicollinearity in an easy and suitable manner (Murthy, 2002).

Mostly the Stochastic Frontier Analysis is directed towards predicting the effects of inefficiency. Technical Efficiency in this study was computed by using the common output oriented measure of technical efficiency which is given by the ratio of firm's output to the corresponding stochastic frontier output or in other words Technical efficiency is defined as the ratio of the observed output to maximum possible output that is given as follows:

$$TE_i = \frac{q_i}{f(X_i' \beta)} \dots \dots \dots (4)$$

The observed output can be expressed in terms of exponent as follows:-

$$\exp(q_i) = \exp(X_i' \beta + V_i - U_i) \dots \dots \dots (5)$$

The maximum possible output can be expressed in terms of exponent as follows:-

$$\exp(q_i) = \exp(X_i' \beta + V_i) \dots \dots \dots (6)$$

Therefore by substituting equations (5) and (6) into equation (4) the measure of technical efficiency can now be expressed as:

$$TE_i = \frac{\exp(X_i' \beta + V_i - u_i)}{\exp(X_i' \beta + V_i)} = \exp(-u_i) \dots \dots \dots (7)$$

Source: Coell et al (2005)

Technical efficiency coefficient normally ranges between zero and one values. Coell *et al.* (2005) insisted that the value of technical efficiency ranges between zero and one. When Technical efficiency equals 1 means the farmer produces with fully

technical efficiency, when technical efficiency < 1 means the farmer is not making the most, out of the inputs used (Ilembo and Kuzilwa, 2014). If the value of U_i in equation (7) above is zero then TE becomes 100% and the farmer is assumed to be technically efficient, that means the value of actual output equals the value of maximum possible output.

In second step, the determinants of technical inefficiency were modeled by using Technical inefficiency (dependent variable) against socio economic factors (dependent variables) and became:-

$$D_i = d_0 + d_1 HI + d_2 FE + d_3 CC + d_4 ES + d_5 A + d_6 HS + d_7 MS + d_8 S + d_9 ED \dots \dots \dots (8)$$

Whereby

d_s = unknown parameters to be estimated

D_i = Technical inefficiency of the i th small scale farmer

HI = Famer's total income

FE = farming experience

CC = cultivation cost

ES= Extension service (Dextension service dummy variable, 1 if a farmer accessed extension services, 0 otherwise)

A= respondent age

HS= Household size

MS= Marital status of respondent (Dsingle dummy variable, 1 if a farmer is single, 0 otherwise; Dseparated dummy variable, 1 if a farmer has been separated, 0 otherwise; Dwidow (er) dummy variable, 1 if a farmer is a widow(er), 0 otherwise and Dmarried dummy variable, 1 if a farmer is married, 0 otherwise.

S= Sex of respondent (dummy variable 1 if a farmer is male, 0 otherwise)

ED = Education level of the farmer, (DstdVII dummy variable, 1 if a farmer has primary education, 0 otherwise; DformIV dummy variable, 1 if a farmer has form IV education, 0 otherwise; DformVI dummy variable, 1 if a farmer has form VI education, 0 otherwise; Dcertificate dummy variable, 1 if a farmer has certificate level of education, 0

otherwise; Ddiplomadummy variable, 1 if a farmer has diploma level of education, 0 otherwise and Ddegree dummy, 1 if a farmer has degree level of education, 0 otherwise)

The study tested the following hypotheses in determining the operationalization of the specific model functional form and variables applied: The first Null hypothesis (H0) states that the model was not appropriately specified, its alternative hypothesis (H1) states that the model was appropriately specified. This hypothesis aimed at finding if the model specification for the study was proper between the popular functional forms of the stochastic frontier methods between Translog and Cobb Douglas production functions.

The second hypothesis tested the chosen model if it was correctly specified and the Null hypothesis (H0) stated that, the chosen model was appropriately specified and the Alternative Hypothesis (H1) stated that, “the chosen model was not appropriately specified”.

The third null hypothesis states that farmers are fully technical efficient in the study area, its alternative hypothesis states that farmers in the study area are not fully technical efficient. This test of the hypothesis aimed in achieving the specific objective number two which states “To determine the level of technical efficiency of small scale cotton farmers in Bariadi district”.

The fourth null hypothesis states that socio economic factors jointly do not have influence on cotton productivity in the study area, its alternative hypotheses states that socio economic factors jointly have influence on cotton productivity in the study area. This test aimed at achieving specific objective number two and three which states “To examine household level factors influencing technical efficiency of the small scale cotton farmers in Bariadi district.” The third specific objective states “To examine farm level factors influencing technical efficiency of the small scale cotton farmers in Bariadi district.

3.8.3 Econometric tests

Data collected from the survey were subjected to different econometric tests in order to ensure that they are suitable for use and provide best results. This study used different econometric tests for various reasons. Such tests were test for heteroscedasticity, test for multicollinearity and test for specification of the model.

3.8.3.1 Test for heteroscedasticity

Heteroscedasticity is referred to as a situation whereby the variances of error terms in the model are not equal, Gujarati, (2004). This happens when the assumption number four of the CLRM which suggests that the disturbances of the population regression function are homoscedastic; that means; they all have the same variance. Heteroscedasticity has some consequences which are related with causing estimated coefficients to be unbiased but inefficient, the variances may become either too small or too large, leading to Type I or II errors under heteroscedasticity and therefore OLS becomes not BLUE (Best Linear Unbiased Estimator). Due to the fact that data vary among themselves and in this study in particular the researcher was worried with variations that could arise from the use of the different variables. Therefore in order to be sure of overcoming the problem of heteroscedasticity the numeric variables were transformed into natural logarithm and conducted a test for heteroscedasticity test by using the Breusch-Pagan / Cook-Weisberg.

3.8.3.2 Test for model specification

The study performed this test in two stages; the first was on choosing the correctly functional forms to be applied between the popular functional forms of the stochastic frontier methods (Translog and Cobb Douglas production functions).

The second stage of this test aimed on examining the significance of the chosen model (Cobb Douglas or Translog) and the relevance of variables in inefficiency

function. The “link test” was applied where by Null hypothesis (H_0) stating that model was appropriately specified and the Alternative Hypothesis (H_1) stating that, model was not appropriately specified were tested.

3.8.3.3 Test for multicollinearity

Andren (2007) defines multicollinearity as a situation where there is high correlation among the explanatory variables in a multiple regression model. Gujarati (2004) defines multicollinearity as the situation existing when there is perfect or exact linear relationship among some or all explanatory variables in the regression model. Assumption no 10 of the CLRM states that “There is no perfect multicollinearity”. That means, there are no perfect linear relationships among the explanatory variables. Test for multicollinearity in this study was done by using the Variance Inflation Factor (VIF) test to see whether there was perfect or exact linear relationship among explanatory variables in the regression model applied. The VIF is given by the relation:

$$VIF = \frac{1}{1 - r_{23}^2}$$

Whereby;

r_{23}^2 = coefficient of correlation between X_2 and X_3 .

According to Gujarati (2004), the decision rule is based on the fact that as the VIF of a variable increases and exceeds 10, that variable is said to be highly collinear and if the VIF approaches 1 the variable is said to be less collinear. This study employed both qualitative and quantitative explanatory variables, qualitative explanatory variables (dummy variables) which were tested for multicollinearity by introducing dummy variables which were less by one of the categories of variables. The essence of so doing was to avoid perfect linear relation between the set of dummy variable and the constant (dummy variable trap).

3.9 Ethical issues

The study considered ethical issues such as respecting the respondents, doing no harm to the respondents, selecting the respondents fairly, keeping confidentiality of information provided by respondents so as to ensure privacy and dignity of research participants.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.1 Introduction

This chapter is concerned with presentation of results for the analysis carried out using the data collected from 128 small scale cotton farmers in Bariadi District. The analysis is mainly divided into two sections which are descriptive analysis and the inferential analysis.

4.2 Descriptive results

This part includes descriptive results for both factors of production and the variables used to determine the level of technical efficiency in the study area. Results for variables that determine technical efficiency includes age of respondents, education level, sex, farmers' total income, cultivation cost, farming experience, extension service, household size and marital status. Variables for factors of production include quantity of cotton seeds planted, quantity of pesticides and farm size of the land cultivated. All the variables have been summarized in table 4.2 below.

Sex of respondent was categorized as males and females; the variable sex was predicted to involve more males than females in cotton production. Results indicate that female headed households were only 18.8% while male headed households were 81.2%. This male dominance in cotton production could be due to the nature of cotton production itself since cotton farming is a labour intensive crop and as a cash crop which preferably interest more males than females.

Age of respondent (the head of the household) is one of the important factors that was included in the study. The results from this study indicated that the age of respondents ranged between 21 to 67 years and the overall mean age of respondents

was 41 indicating that the households' head who cultivate cotton in the study area are relatively middle aged ones.

Education level of respondent in this study was classified into six dummy categories: standard VII, Form IV, Form VI, certificates, diploma and degree. Those who had no formal education accounted 16.4 percent while those with formal education account 83.6 percent of total small scale cotton farmers responded. Farmers who had formal education were categorized as follows: those who completed standard VII comprised of 60.9 %, Form IV comprised of 13.3 %, Form VI composed of 1.6%, those having certificates comprised of 3.9 %, those with diploma comprised of 3.1 % and lastly those with degree comprised of 0.8 % of the total number of respondents in the study area.

Marital status of the respondent in this study was classified into four dummy categories: single, divorced, widow or widower and separated. Married respondent accounted 73.4 percent while unmarried respondents accounted 26.6 percent of total small scale cotton farmers responded. Farmers who were not married were categorized as follows: single respondents comprised of 10.2 %, separated respondents comprised of 4.7 %, divorced respondent composed of 1.6 % and lastly widow or widower comprised of 10.2% of the total number of respondents.

Farmer's total income is referred to as the combined gross revenue of the farmer from various sources. It consists of every kind of earnings together with salaries, wages, retirement income, government transfers and gains from investment. The results indicate that farmer's annual total income ranged between 600,000/= and 8,770,000/= and that the mean income for the households was 2,933,126/=.

Farming experience results indicate that the experience ranged between 2 and 30 years and that the mean farming experience was 10 years. Large proportion of farmers are between 6 to 10 years which comprises about 35% of the total farmers while the small proportion of farmers have the experience above 20 years.

Cultivation cost is referred to as the cost incurred through the action of tilling the ground by hoeing or ploughing before planting the seeds. Results indicate that cultivation cost from this study averaged 80,453/= and ranged between 27,000/= and 180,000/= for a cultivated land.

Pesticide quantity averaged 33.59 litres and it ranged from 6 to 80 litres for a particular land cultivated. This variable was determined by size of the farm cultivated, the number of sprays applied. As far as quantity of seed is concerned, cotton farmers in the study area used seed quantity which averaged 18.85 kg and it ranged from 12 kg to 80 for a piece of land cultivated.

Provision of extension services is so important to farmers in improving their performances. This variable was also included as an explanatory variable. The results indicate that farmers who accessed extension services through contacts with the extension agents were 68 % that means other farmers about 32% of total small scale cotton farmers in the study area had no access to extension services.

The average household size of farmers in the study area was 7 members. The large proportion of farmers included households with members between 6 and 7 members while the small proportion of respondent included households with 1, 2 and 3 family members, this is due to the fact that families with many members is ensured with enough labour for different farming activities such as cultivation, weeding, pesticide application, weeding and harvest compared to families with few members.

Farm size was among the variables included in this study. This is the size of land that was used for cotton cultivation. Results indicate that the farm size ranged between 1 and 5 acres with the mean farm size of 2.4 acres. The results also indicate that majority of the farmers (28.1%) cultivated in farm sizes of 1 acre and the same proportion cultivated in 2 acres.

Table 4.1: Descriptive statistics for production function and efficiency variables

Variable	Mean	Std error	Minimum	Maximum
<i>Production function variables</i>				
Cotton output (Kg)	1253.7	1.186	102	4016
Farm size (Acre)	2.4	1.186	1	5
Pesticide total quantity (litres)	33.59	17.52	6	80
Seed total quantity (Kg)	37.18	18.848	12	80
<i>Socio economic factors</i>				
Age (years)	40.86	10.262	21	67
No formal education (%)	16.4	0.03		
standardVII (%)	60.9	0.04		
Form IV (%)	13.2	0.05		
Form VI (%)	1.6	0.07		
Certificate (%)	3.9	0.09		
Diploma (%)	3.1	0.2		
Degree (%)	0.8	0.12		
HouseHsize (members)	6.55	2.303	1	12
Cctotal (Tshs)	80500	39790.5	27000	180000
Income total (Tshs)	2930000	1524682	600000	8770000
Farm experience (years)	10.38	6.041	2	30
Accessing extension services (%)	0.68	0.02		
Male (%)	81.2	0.392		
Female (%)	18.8	0.03		
Married (%)	73.4	0.04		
Divorced (%)	1.6	0.1		
Separated (%)	4.7	0.05		
Widow(er) (%)	10.2	0.04		
Single (%)	10.2	0.04		

Source: Survey results (2017)

4.3 Econometric analysis results

4.3.1 Hypothesis testing and variance parameters

The first Null hypothesis aimed at finding the proper model specification between the popular functional forms of the stochastic frontier methods (Translog and Cobb Douglas production functions). The Null Hypothesis (H_0) for hypothesis number one which states that the model was appropriately specified for Translog function and its alternative hypothesis (H_1) stating that the model was not appropriately specified for Translog function were tested by referring the production frontier results that were obtained after running the variables by using two models which are Cobb Douglas and Translog stochastic Production with the major objective of comparing the functional forms before selecting the appropriate one. The test for the Translog stochastic frontier production function was conducted whereby values for the second order and interaction variables included in the model were dropped automatically from the analysis because of the problem of collinearity. One of the major strength of employing the Translog model is to assess the interaction effects of the variables, by referring its results, the first Null hypothesis was rejected due to the fact that Translog model missed economic meaning and therefore the study opted to employ the popular Cobb Douglas production function frontier.

The second Null hypothesis stated that “the applied Cobb Douglas production is appropriately specified” and was tested against its alternative hypothesis (H_1) stating “The model was not appropriately specified. The results obtained from the “link test” indicated the p value of χ^2 to be 0.514 which is not statically significant. Therefore we fail to reject the Null hypothesis and conclude that the chosen Cobb Douglas functional form was appropriately specified.

The third Null Hypothesis (H_0) which states that small holder farmers in the study area are fully technical efficient and its alternative hypothesis (H_1) stating that smallholder farmers in the study area are not fully technical efficient were tested by

referring technical efficiency score results in the study area (see table 4.3.1) which indicates that the average technical efficiency was 0.69 and it ranged from 0.05 to 0.95 meaning that small scale cotton farmers in the study area were not fully technical efficient. Therefore the second null hypothesis is rejected.

The fourth Null Hypothesis (H0) which states that socio economic factors jointly do not have influence on technical efficiency of smallholder cotton farmers in the study area and its alternative hypothesis (H1) which states that socio economic factors jointly do have influence on technical efficiency of smallholder cotton farmers in the study area were tested by referring the maximum likelihood estimation of parameters indicated in the attached appendix 1.

The estimated values for the variance parameters were statistically significant and they indicated that the overall level of cotton productivity was influenced by technical inefficiency. The variance parameter of the model (γ) which is interpreted as the percentage of variation in output that occurs due to technical inefficiency of farmers had the value of 0.59 which is significantly different from zero indicating the existence of inefficiency in the production process. Therefore this value in the study area implies that 59% of variation in cotton production among small scale cotton farmers is caused by the inefficiency in the production process. Furthermore, the presence or absence of technical inefficiency was also tested in the study using the important parameter of log likelihood in the half-normal model assumption (λ), if the value of (λ) obtained was zero then there were no effects of technical inefficiency, and that all the deviations from the frontier were due to noise as in Aigner et al. (1977). The estimation showed the value of lambda was 1.199 which is greater than 1 ($\lambda > 1$) indicating the presence of inefficiency in the model.

Test for heteroscedasticity

Heteroscedasticity is one of the tests conducted to the data obtained to make sure that no violation of the CLRM assumptions is made. Due to the fact that data always vary among themselves and in this study in particular the researcher was worried with

variations that could arise from the use of the different variables such as age of respondent, farming experience, respondent's total income and other used variables. Therefore in order to be sure of overcoming the problem of heteroscedasticity the numeric variables were transformed into natural logarithm and conducted a test for heteroscedasticity by using the Breusch-Pagan / Cook-Weisberg with the Null hypothesis H_0 : there is constant variance for the standard errors and alternative Null hypothesis H_1 : there is no constant variance of the standard errors. The results indicated that is calculated was 32 with the probability value of 0.0000 which is highly statistically significant leading to rejection of the Null hypothesis indicating the existence of heteroscedasticity problem among the variables; in order to solve this problem, the standard errors were adjusted for heteroscedasticity by making them robust standard.

Test for multicollinearity

Always there is relationship between explanatory variables in the model, this study was subjected to the test for multicollinearity to see whether there was strong relationship among explanatory variables in the model before running the model. The study used Variance Inflating Factor (VIF) to find out the existence of multicollinearity problem. Gujarati , (2004) recommended that the value of VIF which is greater than 10 shows the existence of strong relationship between explanatory variables and the value of VIF which is less than 10 indicates less relationship between explanatory variables. The results obtained from the test showed the mean VIF was 1.92 and other values of VIF were less than 10 indicating the existence of less collinearity problem between explanatory variables, See appendix No 3.

Test for model specification

The study performed model specification test in order to examine the significance of the model specified (Cobb Douglas) and the relevance of variables in inefficiency function. The "link test" was applied where by Null hypothesis (H_0) stating that ,the

applied Cobb Douglas model was appropriately specified and the Alternative Hypothesis (H1) stating that, model was not appropriately specified were tested. The results obtained indicated the p value of χ^2 to be 0.514 which is greater than all levels of significance (1%, 5% and 10%), therefore we fail to reject the Null hypothesis indicating that the applied Cobb Douglas production function model was appropriately specified.

4.4 Regression analysis

4.4.1 Production frontier and inefficiency estimates

The results for parameter estimates of the stochastic production frontier which included cotton production as dependent variable, farm size, pesticide quantity and seed quantity as independent variables; the results for parameter estimates of the inefficiency model which included level of technical inefficiency as dependent variable and extension services, education level, marital status, sex, age, household size, cultivation cost, farming experience and farmers income as independent variables are presented in the table 4.2 below:-

Table 4.2 Parameter estimates for stochastic production model and inefficiency model

Variable	Coefficient	std error	Z-ratio	p value
<i>Production function</i>				
cons	51.03	87.77	0.58	0.561
farmsize	400.01***	89.77	4.56	0.000
PestcidTotalquantity	30.40***	8.12	3.37	0.000
SeedTotalquantity	-13.29	8.43	-1.58	0.115
<i>Variance parameters</i>				
Sigma (v)	324.4975	40.04102		
Sigma (u)	389.0131	93.75521		
Sigma sq	256629.8	57887.78		
Lambda ($\frac{\sigma_u^2}{\sigma_v^2}$)	1.199			
Log-likelihood	-947.81***			
LR – test (1)	3.46**			
<i>Inefficiency parameters</i>				
constant	0.359355	0.501935	0.72	0.474
Extension service				
dextension	-0.1085912***	0.0335382	-3.24	0.000
Education				
DstdVII	-0.0122391	0.0342403	-0.36	0.721
DformIV	0.0034855	0.0363074	0.10	0.829
Dcertificate	0.1012637	0.0807611	1.25	0.210
DformVI	-0.0155938	0.0674324	-0.23	0.923
Ddiploma	-0.0095682	0.092098	-0.10	0.917
Ddegree	-0.0326739	0.042153	-0.77	0.438
Marital status				
Dsingle	-0.0407024	0.0535043	-0.76	0.447
Ddivorced	0.4698674**	0.227286	2.07	0.039
Dseparated	0.0333238	0.069153	0.48	0.631
Dwidow	0.0409778	0.0462869	0.90	0.369
Sex of farmer				
Dmale	-0.0172255	0.0431416	-0.40	0.690
Total income				
Incometotal	-0.0506942*	0.0312517	-1.62	0.105
Age of farmer				
Variable	Coefficient	std error	Z-ratio	p value

Age	0.0217366	0.0682918	0.32	0.735
Household size				
HouseHsize	-0.1366322***	0.0441063	-3.10	0.002
Cultivation labour				
Cctotal	0.0870168**	0.0318202	2.73	0.017
Farming experience				
farmexperience	-0.0543476*	0.0286616	-1.90	0.058

Source: Researcher's STATA output

*** Significance level at 1%

** Significance level at 5%

* Significance level at 10%

4.4.2 Technical efficiency score

Calculations made on Technical efficiencies gave the result that indicated technical efficiency of farmers ranged from 0.05 to 0.95 with mean efficiency of 0.69. This implies that small scale cotton farmers in the study area are technically efficient by 69%. The results for technical efficiency estimates are presented in the table 4.3 below:-

Table 4.3 Technical efficiency results

Technical Efficiency	Frequency	%
0.05 - 0.50	19	14.84375
0.51 - 0.60	10	7.8125
0.61 - 0.70	33	25.78125
0.71 - 0.80	34	26.5625
0.81 - 0.90	28	21.875
0.91 - 1.0	4	3.125
Total	128	100

Source: Author's calculations (2017)

4.4.3 Determinants of Technical efficiency

In analysis of technical efficiencies, positive coefficients of determinants of technical efficiencies indicate by how much farmers' technical efficiencies decrease in response to unit increase of percentage increase in explanatory variables, negative coefficients indicate farmers' technical efficiencies increase in response increases in explanatory variables.

Various factors have been studied to have effects on the efficiency of agricultural production and cotton production in particular. Musemwa *et al.* (2013) found that age of household head, excellent production knowledge and level of specialization affected technical efficiency in Zimbabwe. Chisanga *et al.* (2016) found that some attributes of socio economic and farm specific factors had effects on technical efficiency among farmers in Zambia .factors that had positive and significant effects were gender, age squared of the household head, number of household members, age squared, and previous year's quantity of fertilizer and producing of seed cotton in Southern in reference to Central Province .other factors had negative significant effects, these were; age of the household head, number of household members.

This study particularly studied some socio economic factors to see their influence in technical efficiency of cotton productivity. These factors were farmers' age, sex, marital status, total income, family size, education level, access to extension services and cultivation cost. The lower part of Table 4.2 above (inefficiency parameters) shows the determinants of technical efficiency studied with their respective coefficient values, standard error, z ratios and p values.

Farmer's total income

Households' total income is related to cotton productivity through determination of farm sizes in cultivation especially when land is hired, acquisition of farm implements which also have effects on the level of cotton production, therefore

household's income has influence on the productivity of cotton. In this study, the coefficient of the variable had negative sign, that means the variable had negative influence on technical inefficiency, in other words farmers with high total incomes were more technically efficient compared to those with low total incomes, this may be due to the ability to purchase farm inputs and implements and application of other modern agricultural practices that increase cotton productivity. The results indicate that household's income was statistically significant at 10% indicating that total households income contributes towards decreasing technical inefficiency in cotton productivity.

Farming experience

The estimation results indicate that farming experience was found to be statistically significant at 10%. The variable had negative coefficient which implies that farming experience in the study area had negative influence on technical inefficiency, in other words this means that farmers who are more experienced in cotton farming were more technically efficient compared to the less experienced farmers. The finding from this study is comparable to other studies in different locations for instance in Nigeria (Atala *et al*, 2015), in Turkey (Gul *et al*, 2009). Although these studies applied different methodologies but they all found farming experience contributed towards decreasing technical inefficiency.

Total Cultivation cost

Total cultivation cost estimation was found to be statistically significant at 5% indicating that total cultivation cost had positive coefficient indicating positive influence on technical inefficiency. This implied that farmers with high total cultivation costs were less technically efficient compared to those with low total cultivation costs. These findings contradict the results by Anwary (2009) who revealed that the coefficient for the variable of cultivation cost had positive influence of cotton production by 11.3 percent.

Household size

Estimation results show that Household size was statistically significant at 1% and had negative coefficient indicating negative relation on technical inefficiency, that means farmers with many family members were more technically efficient compared to those with few family members, this is due to the fact that families with many members are ensured with the supply of enough labour for different farming activities such as cultivation, weeding, pesticide application, harvest and transportation compared to families with few members. These findings resemble to a study conducted by Dolisca and Jolly (2008) which identified a positive influence of household size on technical efficiency.

Extension services

Extension services were defined as the number of visits the extension agent makes to the farmer with the aim of providing advice concerning cotton production. The estimation results indicate that extension services were found to be statistically significant at 1% and negatively influences technical inefficiency. This implies that farmers who get extension services through contacts with extension agents improve their technical efficiency than those who lack the service. This results resembles what Olarinde (2011) found about extension services by indicating that among other variables, extension service determine technical efficiency in Nigeria. Chiona (2011) also found extension services to have positive effects on technical efficiency among farmers in Zambia.

Marital status

Marital status of farmers was categorized into 2 major groups, married and unmarried. It was further categories into four dummies, single, separated, divorced and widow or widower while married were fixed as reference. The findings reveal that the values for single, separated, widow or wider were statistically insignificant in

explain the technical efficiency of farmers. Divorced farmers had a positive coefficient value that is statistically significant at 5% indicating a positive influence on technical inefficiency unlike the married ones. This means that farmers who were divorced are technically inefficient compared to the married farmers.

CHAPTER FIVE

DISCUSSION OF THE FINDINGS

5.1 Introduction

This chapter discussed in details the findings obtained in the previous chapter. The detailed discussion starts with descriptive results followed by stochastic model results, technical efficiency scores and finally factors influencing technical inefficiency.

5.2 Descriptive statistics

This part includes descriptive analysis of the socio economic characteristics of the small scale cotton farmers in the study area which are age, education level, sex, household total income, farming experience, cultivation cost, pesticides cost, seed quantity, access to extension service, household size, farm size and marital status.

The results from this study indicate that age of respondents ranged between 21 to 67 years and the overall mean age of respondents was 41 indicating that the households' head who cultivate cotton in the study area are relatively middle aged ones this implies that in the study area, large proportion of the farmers are young and capable of conducting cotton cultivation which by nature it is a labour intensive work, Alam *et al.* 2013; Atala *et al.* 2015 had similar observation on composition of farmers being largely dominated by the middle aged ones. Similarly, results indicate that female headed households were 18.8% while male headed households were 81.2%. this male dominance in cotton production could be due to the nature of cotton production itself since cotton farming is a labour intensive crops and as a cash crop which preferably interesting more males than females. The results are consistent with other studies on cotton productivity which indicated that female headed farmers were fewer than male headed farmers for instance in Nigeria (Alam *et al.* 2013 and Atala

et al. 2015) indicated male dominance in cotton production by 88% and 90% respectively.

With regard to the marital status, results indicated that married respondents dominate largely in cotton production unlike the unmarried ones. The large composition of married respondents is largely explaining the dependency of labour force in cotton farming since married households are assured of large number of household members who can work on various activities in farms, Musemwa *et al.* (2013) had similar observation. Whereas, the results on education indicated that a large proportion of farmers in the study area had acquired the basic education that could be helpful in implementing different activities while farmers who had never been to school at all and those with post-secondary education composed a small proportion of farmers in the study area. It also implies that majority of small scale cotton farmers in the study area have the awareness of important issues related to cotton production. Rehman and Muhammad (1999) had similar observation on the composition of farmers in various levels of education.

As far as farming experience is concerned, the results indicate that farming experience ranged between 2 to 30 years and that the mean farming experience was 10 years. Large proportion of farmers are between 6 to 10 years which comprises about 35% of the total famers while the small proportion of farmers have the experience above 20 years . Alam *et al.* (2013) indicates that, greater number of the farmers in their study had sufficient farming experience to improve their cotton output. According to the study farming experience implies that majority of farmers have been in cotton farming business for a long time and are therefore conversant with the problems of cotton production in the area. Alam *et al.* (2013) in Nigeria had similar observation when they found the mean farming experience in their study area to be 9 years.

On the other hand, pesticide cost was determined by the size of the farm cultivated, the number of sprays applied on the farm and quantity of pesticides applied per quantity land. Pesticides cost in this study ranged between 15,000/= and 180,000/=

with an average of 78,668/=. Pesticides quantities used were measured in litres; results indicate that pesticides applied ranged from 6 to 80 litres with a mean of 33.59 litres. Whereas, household total income in the study area had an average of 2,933,126/= per year from various sources. Households' total income was related to cotton productivity through determining the size of farms to be cultivated especially when land is hired, acquisition of farm implements which also have effects on the level of cotton production, therefore household's income has influence on the productivity of cotton. Based on the findings of this study, households' total income can support farmers to purchase important farm implements and inputs.

With regard to seeds, results show that seed quantity applied in this study ranged between 12 kg and 80 kg in a cultivated farm with a mean seed quantity of 18.85 kg. This implies that farmers in the study area are using seed quantity on their farms according the requirements. Household's size was linked by the supply of family labour on various farm activities. The family size found in this study had an average household size of 7 members which tells that farmers' families in the study area have enough members who could work on various farm activities such as cultivation, weeding, pesticide application and harvesting. Whereas, results for the farm size indicate that large proportion of farmers in the study area were small scale farmers. Results indicate that the farm size ranged between 1 and 5 acres with the mean farm size of 2.4 acres implying that most of them are smallholder farmers. It was further noted that provision of extension services was so important to farmers in improving their performances. The results indicate that large proportion of farmers (68%) accessed extension services at least once a year while small proportion about 32% of total small scale cotton farmers in the study area had no access to extension services.

5.3 Stochastic model results

Stochastic model indicated that household size estimation results were found to be -0.1366322 for coefficient, 0.441063 for standard error, -3.10 for Z ratio and 0.002 for probability value. These results show that Household size was statistically significant at 1% and was negatively related to technical inefficiency, that means households with large size were more technically efficient compared to those with fewer family members. This result is supported by Karimov (2014) who conducted a study on factors affecting efficiency of cotton producers in rural Khorezm in Uzbekistan and Dolisca and Jolly (2008) who found negative influence of household size to technical inefficiency of farmers.

As far as the households' total income is concerned, obtained results show that the values were -0.0506942 for coefficient, 0.0312517 for standard deviation, -1.62 for z-ratio and 0.105 for p value (see appendix 2). These values indicate statistical significance of the coefficient at 10% level of significance and negatively related to technical inefficiency. These results imply that farmers with relative high total incomes resulted from various sources of incomes in the study area are more technically efficient compared to their counterparts with relative lower total incomes. This result is supported by Chiona (2011) who conducted analysis of technical efficiency of maize in Zambia and found similar results.

With regard to farming experience which was initially predicted to have positive influence on technical efficiency of cotton farmers in the study area, the estimation results obtained show that the values were -0.0543476 for coefficient, 0.02886616 for standard deviation, -1.9 for z-ratio and 0.058 for p value as shown in appendix 2. These values indicate statistical significance of the coefficient at 10% level of significance and positive effect on technical efficiency. The results imply that farmers who are more experienced in cotton farming in the study area are more technically efficient than the less experienced farmers. The finding is supported by Atala *et al.* (2015) in Nigeria and Gul *et al.* (2009) in Turkey.

Sex of farmer is the variable that was predicted to have positive effects for males on technical efficiency and negative effects for females on technical efficiency. Inferential results found the coefficient for male farmers to be -0.0172255 with the expected negative sign, value of standard error was 0.0431416 the value of z ratio was -0.40 and probability value was 0.636, although the values were not statistically significant, the negative sign of the coefficient indicate that male headed farmers were more technically efficient than female headed farmers. The result is supported by Atala *et al.* 2015 in Nigeria and Chisanga *et al.* 2016 in Zambia.

It was further noted that cultivation cost which was one of the variables initially predicted to have positive effects on technical inefficiency of farmers in the study area, its estimation results found coefficient for this variable to be 0.0870168, value of standard error was 0.0363243, the value of t ratio was 2.40 and probability value was 0.017. The value obtained were found to be statistically significant at 5% indicating that total cultivation cost had negative influence on technical efficiency. This result contradicts Anwary 2009 in Pakistan.

With regard to access to extension services which was predicted to have negative effects on technical inefficiency of farmers in the study area, the estimation results found coefficient for this variable to be -0.1085912 with the expected negative sign, value of standard error was 0.0335382, the value of z ratio was -3.24 and probability value was 0.000. This indicated that extension services were found to be statistically significant at 1% and positively influences technical efficiency. The result is supported by Olarinde, (2011) in Nigeria and Chiona (2011) in Zambia.

Finally, marital status was another variable which was taken into consideration. The estimations for one of the coefficients, that is divorced was -0.4698674; coefficients for other categories were found to have the positive sign. Among all marital status categories, divorced farmers were found to have statistically significant z-ratio and probability value which are 2.07 and 0.039 respectively. This result is supported by Musemwa *et al.* (2013) in Zimbabwe.

5.4 Technical efficiency score

Estimated results made on technical efficiencies gave the result that indicated technical efficiency value of small scale farmers in the study are to range from 0.05 to 0.95 with mean efficiency of 0.69. This implies that small scale cotton farmers in the study area are technically efficient by 69%.the results also from table 4.3.1 indicate that a proportion of about 26.5% of farmers are technically efficient within 0.71 – 0.8. despite these results the overall observation show that an average of 31% of cotton farmers are still technically inefficient, this implies that farmers are still not utilizing farm inputs to the optimal level and that there is a room for them to improve their technical efficiencies by 31% without increasing level and cost of inputs.

5.5 Factors affecting technical efficiency

5.5.1 Household's total income

Households' total income was predicted to be related in cotton productivity through determining the size of farms to be cultivated especially when land is hired, acquisition of farm implements which also have effects on the level of cotton production.

Results obtained show that its values indicate statistically significance of the coefficient at 10% level of significance and negative effect on technical inefficiency due to negative coefficient. This implies that in the study area, household's total income was negatively related to technical inefficiency, that means farmers with high total incomes obtained from various sources were more technically efficient compared to those with low total incomes, this may be due to the ability to purchase farm inputs and implements and application of other modern agricultural practices that increase cotton productivity. This result is supported by Chiona (2011) who conducted analysis of technical efficiency of maize in Zambia and found similar results.

5.5.2 Farming experience

This variable was predicted to have positive influence on technical efficiency of cotton farmers in the study area. This implies that farmers who have been growing cotton for several years are more technically efficient compared to those with less experience. These effects could be due to increasing farmers' solving problems ability related to cotton production, adoption of new farming techniques. The findings is supported by Atala *et al.* (2015) who found that years of farming experience increased agricultural productivity among farming households in Nigeria. Other findings by Gul *et al.* (2009) who examined technical efficiency by using Data Envelopment Analysis (DEA) and Tobit regression identified farming experience to have positive effects on technical efficiency.

5.5.3 Total cultivation cost

This variable was predicted to have positive effects on technical efficiency of farmers in the study area. The values obtained were found to be statistically significant at 1% indicating that total cultivation cost had negative influence on technical efficiency. This implied that farmers with high total cultivation costs were less technically efficient compared to those with low total cultivation costs. These findings contradict results by Anwary (2009) who revealed that the coefficient for the variable of cultivation cost had positive influence of cotton production by 11.3 percent.

5.5.4 Household size of the farmer

This variable was found statistically significant at 1% and is positively related to technical efficiency, that means farmers with many family members were more technically efficient compared to those with few family members, this is due to the fact that families with many members are ensured with the supply of enough labour for different farming activities such as cultivation, weeding, pesticide application,

harvesting and transportation compared to families with few members. This findings is supported by Karimov (2014) who conducted a study on factors affecting efficiency of cotton producers in rural Khorezm in Uzbekistan and found household size to influence technical efficiency of farmers positively. The findings are also supported by Dolisca and Jolly (2008) who found positive influence of household size to technical efficiency of farmers.

5.5.5 Extension service

The estimation results indicate that extension services were found to be statistically significant at 1% and positively influences technical efficiency. This implies that farmers who got extension services through contacts with extension agents improved their technical efficiency than those who did not access the service. These results are supported by Olarinde, (2011) who found the variable to have positive influence on technical efficiency to farmers in Nigeria. Chiona (2011) also found extension services to have positive effects on technical efficiency among farmers in Zambia.

5.5.6 Marital status of respondent

The aim of including this variable was to see whether there were significant differences in influencing the farmers' technical efficiency among farmers who are married, single, divorced, separated and widow or widower. Although the variable was statistically significant at 5%, its positive coefficient value indicate negative influence on technical efficiency, that means divorced farmers were found to decrease their technical efficiency compared to the married farmers. These findings were supported by Musemwa *et al.* (2013) in Zimbabwe who found that married farmers increase their technical efficiencies compared to unmarried farmers.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Summary

This study was mainly focused on determining the effects of socio economic factors on technical efficiency of small scale cotton farmers in Bariadi. Data were analyzed through the use of stochastic frontier (Cobb Douglas) Production function. Technical efficiencies levels of farmers were calculated by using the Stochastic Frontier Analysis Program version 4.1 and the level of technical efficiencies were subjected to different socio economic factors in order to assess their influences on technical efficiency.

The findings indicated that technical efficiencies values of small scale cotton farmers in the study area ranged from 0.05 to 0.95 with mean efficiency of 0.69 and was found to be influenced positively by farmer's total income with 10% level of significance; farming experience was found to be statistically significant at 10% level of significance; Household size of the farmer was found to be statistically significant at 1%; extension services was found to be statistically significant at 1%. These findings imply that farmers have the mean technical efficient of about 69% meaning that they can still utilize the remained 31% to be fully technical efficient. As far as the farmer's total income is concerned its implications that if total income of small scale cotton farmers in the study area increases it also improves technical efficiency of farmers; With regard to farming experience, it is summarized that as farmers increase their duration in cultivating cotton they improve their technical efficiency implying that the initiatives aiming towards improving cotton productivity should not leave the experience farmers behind. Household size findings imply that cotton cultivation is still relying on man labour whereas extension services is fairly provided and implying its significant contribution towards increasing technical efficiency to farmers in the study area.

Other variables had negative influence on technical efficiency, such variables were marital status which was one of the variable studied whereby divorced farmers were found to be technically inefficient compared to married farmers; total cultivation cost was found to be statistically significant at 5% but with negative influence on technical efficiency. The findings have the following implications; households headed by the separated couples were less technically efficient whereas married couples were more technically efficient.

However, other factors that were included such as farmers' education and sex of farmer had results that were statistically insignificant in determining the level of technical efficiencies of farmers in the study area. Their implication on the findings is that the level of technical efficiency of the small scale cotton farmers in the study area is not significantly contributed by these variables but others.

6.2 Conclusion

Based on the discussion presented in chapter five and summary of the findings, the study concludes that women participation in cotton farming in Bariadi is district needs to be strengthened against the current male dominance; as far as the technical efficiency is concerned, farmers need various initiatives by the government and other stakeholders in order to improve their technical efficiency since there is still that opportunity by 31%.

6.3 Recommendations

This study recommends different measures to all key stakeholders of cotton in order to improve technical efficiency and cotton productivity in the study area. The study recommends that the government and other stakeholders to take actions that will improve access to extension by employing and sending more extension officers in places reached by most farmers.

The study recommends that government initiatives should be increased to increase the level of education to farming communities by attracting the educated people to involve themselves more in cotton cultivation. Furthermore, the study recommends more initiatives by the government and other stakeholders to be taken towards increasing women involvement so as to reduce the existing gender gap of cotton production in the study area which is so huge.

With regard to household size which was found statistically significant in determining technical efficiency of farmers, the findings also implied that cotton production in the study area is still dominant on households' labour for most of the activities such as ploughing, weeding, pesticide application and harvesting; the study recommends government and other stakeholders to take actions towards shifting the production to a modern agricultural practices which is more efficient.

The study recommends farming education on various aspects of cotton farming such as measures against pests and diseases should be provided and there should be other means of irrigation that will be the solution to adverse climatic conditions such as drought

The study recommends government initiatives and other stakeholders to improve infrastructures such as roads that will facilitate timely provision of inputs, implements, access to markets and contact with extension agents.

The study recommends timely supply of inputs such as pesticides and seeds and also the use of improved seeds should be made to improve farmers' technical efficiency and cotton production.

6.4 Policy implications

This study urges the government, policy makers and other stakeholders to take seriously consideration in implementing various policies, plans and strategies that may have effect on improving technical efficiency and productivity of small scale

cotton farmers that will eventually trigger agricultural and economic development to the people in the study area and Tanzania as a whole.

Some of policies, strategies and plans that have been set in Tanzania for improvement of agriculture sector are the Tanzania 2025 Development Vision which give more focuses on improving crop production and productivity levels; promoting wealth creation for the benefit of all stakeholders; and spearheading increased domestic processing of goods to enhance value addition and manufacturing industrialization .Kilimo Kwanza initiative give more focus on agricultural infrastructural development; application of new technologies; promotion of higher yields and larger crop production volumes, commercial farming, as well as contract farming; and establishment of forward and backward agro- processing industries.

These policies will bring more meaningful results in the study area if their implementation will be on aspects that can have direct influence on improving technical efficiency and productivity to cotton. Important aspects in Bariadi district based on the findings of this study that need government and other stakeholders' initiatives through different policies are timely provision of inputs and implements to farmers to enhance cotton cultivation within the season, setting price that reflect costs of production, Inputs suppliers should supply agricultural inputs such as fertilizers, seeds and pesticides at prices affordable to farmers.

6.5 Limitation of the study

This study was limited on the cross sectional data which covered the 2015/2016 agricultural season, it was also limited to small-scale cotton producers in Bariadi district in Simiyu region and lastly the study was limited on the time provided for undertaking research after completing course work.

6.6 Area for further research

This study conducted productivity analysis of small scale cotton farms in Bariadi district and one of its objectives was to determine the level of technical efficiency of small scale cotton farmers in Bariadi district, the study did not conduct allocative and economic efficiency of small cotton farmers in the district, therefore this study suggests that other studies should focus on analyzing allocative and economic efficiency of small scale cotton farmers in the district.

This study used cross sectional data in conducting productivity analysis of small scale farms in Bariadi district, the study suggest that other studies should be conducted in the district by using time series data so as to assess the long time effect to small scale farmers.

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QUESTIONNAIRE

PRODUCTIVITY ANALYSIS OF SMALL SCALE COTTON FARMS IN BARIADI DISTRICT, TANZANIA

Dear respondent,

I am Mathew William, a student at Mzumbe University in Morogoro, Tanzania, I am conducting a research on **productivity analysis of small scale cotton farms in Bariadi, district- Tanzania**. Information required in this research is for academic purposes only. You are among the people who have been selected to participate in this study to obtain your contribution, perceptions and views regarding various issues on parametric analysis of productivity in small scale cotton farms in Bariadi district. There are no wrong answers but your honest participation in answering the questions will assist in identifying the factors affecting cotton productivity in Bariadi district. Please don't worry about the information you provide since will be kept confidentially.

SECTION A-1: GENERAL INFORMATION

1. Region:.....
2. District:.....
3. Ward:.....
4. Village/Mtaa:.....
5. Village /Mtaa chairperson:.....
6. Head of household's name:.....
7. Household size:.....
8. Date..... Month..... Year:.....

SECTION A-2: PERSONAL PARTICULARS

	1. NAME List household members starting with head of household in number 1.	2. Sex M...1 F....2	3. Age Years	4. Education level None.....1 Standard VII.. 2 Form IV.....3 Form VI..... 4 Certificate.....5 Degree..... 6	5.Number of schooling years	6. Marital Status Single.....1 Married.....2 Divorced.....3 Separated.....4 Widow(er).....5
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

SECTION B -1 CROP CULTIVATION, PLANTING AND HARVESTING

9. Was area harvested equal to area planted? Yes.....1 No.....2	10. If NOT What were the reasons that it was less than the area planted? Drought.....1 Effects of rain.....2 Fire.....3 Insects.....4 Animals.....5 Crop theft.....6 Diseases & community problems.....7 Lack of casual labour.....8 Other (specify).....9	11. How many kilograms of seed cotton did you harvest per acre last season?	12. What was the total harvest in kilos last season on cotton?

SECTION B-2: CROP SPECIFIC- SALES

1. How many acres in total did you cultivate last season?	2. Did you plant cotton in all acres? Yes ...1 No ...2	3. How many acres were planted cotton?	4. Why didn't you plant the cotton in all acres Need for food..1 Lack of seeds...2 Drought.....3 Lack of loans....4 Disease and pests.....5	5. Was cotton intercropped? YES.....1 NO.....2	6. What was the reason for the intercropping? As caution against crop failure..... .1 Lack of enough fields.....2 Like intercropping.....3 For Improving soil fertility....4 Other.....5	7. Did you harvest from all fields /area last season? YES.....1 NO.....2	8. What was the area/ number of acres harvested in the last season?

1. Did you sell the cotton produced in the last season? YES.....1 NO.....2	2. What was the quantity sold? KGS	3. What was the price per Kilo? TSH	4. What was the total value of the sale? TSH.	5 What was the methods of selling Buyers searching for producers....1 Taking the produce to the market.....2 Selling to marketing cooperatives..3 Other (mention).....	6. How many buyers this season One.....1 More than One.....2	7. When was the relationship established? Less than a week.....1 Less than a month.....2 A month ago.....3 Six months ago.....4 One year ago.....5	8. Are buyers residents or visiting? Resident..1 Visiting...2

9. Where do the visiting buyers come from?	10. Have there been changes from previous season? YES...1 NO....2	11. What are the changes? Explain. Increased number of visiting buyers...1 Increased number of local buyers...2	12. How is quality of the crop assessed/determined? Laboratory testing.....1 Physical looking....2 Historical production of a crop....3	13. Who does the grading of the crop? Farmer.....1 Sponsor.....2 Special grader.....3 Other (specify).....4	14. What things does the price offered depend on? Quality.....1 Quantity.....2 Time.....3 Other4	15. Did you transport crop for sale? YES.....1 NO.....2	16. What is the average distance you transported for sale? 0-5KM.....1 6-10KM....2 11-15KM...3 16-20KM...4
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SECTION C-1: OTHER CROPS PRODUCED

1. List by ranking all other important crops you cultivated last year?	2. How much did you harvest per acre in each crop?	3. What was the sales price per kilogram?	4. What was the total revenue obtained from sales of crop per acre?	5. What was the total cost of operations/production and harvesting for each crop per acre?
CROP NAME SIZE/ Acre.	KGS	TSH.	TSH	TSH.

SECTION C-2: CASH PURCHASE OF INPUTS

1. Did you purchase one of the following inputs during the last season?	2. How much inputs were purchased?	3. How much did you pay for these inputs?
YES.....1 NO.....2	KGS/Litre/Chart	TSH.
Seeds	Seeds	Seeds
Organic fertilizer	Organic fertilizer	Organic fertilizer
Inorganic fertilizer	Inorganic fertilizer	Inorganic fertilizer
Pesticides/Herbicides	Pesticides/Herbicides	Pesticides/Herbicides

4. From whom did you purchase/obtain these inputs? Cooperative...1 Stockist.....2 Trader.....3 Other.....4 Ginners.....5	5. How was the inputs used? For the intended crop.....1 Together with another crop(s).....2	6. Were the inputs supplied used during the farming period? Yes...1 No....2	7. What type of seed did you use last season? Hybrid....1 Local....2	8. Where did you obtain your seeds? Purchased from seed stockists.....1 market.....2 Ginners.....3 cooperatives.....4 from previous harvest.....5	9. Why didn't you use hybrid seeds(improved seeds) Lack of Funds.....1 Lack of Seeds.....2 Not necessary.....3

SECTION D-1: SOURCE OF LABOUR - HOUSEHOLD LABOUR				HIRED LABOUR
LIST HOUSEHOLD MEMBERS HERE	1. During the last cropping season, how many days did household members spend on the following activities per acre of cotton produced?			2. Did you hire any labour to work on this crop in the last season?
	Land preparation & Cultivation Harvesting (DAYS)	Weeding (DAYS)	(DAYS)	YES.....1 NO..... 2
TOTAL				

SECTION D-2 HIRED LABOUR					
LAND PREPARATION AND CULTIVATION		WEEDING		HARVESTING	
MAN DAYS	TOTAL WAGE PAID (TSH.)	MAN DAYS	TOTAL WAGE PAID (TSH.)	MAN DAYS	TOTAL WAGE PAID (TSH.)

SECTION E: FARM IMPLEMENTS AND MACHINERY AND COST								
Please give details of farm implements used or owned by the household last season.								
No.	ITEM	1. How many items do the household own?	2. What is the value of an item if sold now? TSH.	3. Did you use any farm implements during the last season? YES.....1 NO.....2	4. What farm implements did you use in the cultivation of the cotton? (Tick the appropriate)	5. What was the Total cost of pesticides used per acre in the last season? TSHs	6. What was the quantity of cotton seed applied per acre during last season? KGS	7. What was the total cost of cotton seed incurred per acre during the last agricultural season? TSHs
1	Hand hoe							
2	Hand powered sprayer							
3	Oxen/livestock							
4	Ox- plough							
5	Ox seed planter							
6	Ox cart							
7	Tractor							

8	Tractor Plough							
9	Farm building/storage facilities							

SECTION F: EXTENSION SERVICES

1. Did you receive any agricultural advice in the last production season? YES.....1 NO.....2	2. What type of agricultural advice did you receive? Cultivation.....1 Marketing.....2 Prevention of crop disease.....3 Sorting.....4 Grading.....5 Storage.....6 Transport.....7 All the above.....8 Other (specify).....9	3. Where did you mostly receive the agricultural advice from? Government1 Cooperatives.....2 Farmers Association.....3 Buyers/Traders.....4 Small scale farmers network....5 Experienced farmer.....6 Relative (s) within family.....7	4. How many times did you receive extension services last season? Once.....1 Twice.....2 Thrice.....3 More than three times.....4 Put "0" if never

SECTION G: FARMING EXPERIENCE

	1. How many years have you been cultivating cotton?

SECTION H-2: SELF EMPLOYMENT

1. Did you employ yourself in any business activity in the last year other than agriculture? YES.....1: NO.....2	2. What kind of business did you operate? Fishing.....1 Livestock keeping.....2 Carpentry.....3 Masonry.....4 Petty business.....5 Other (specify).....6	3. How much income did you earn per DAY/MONTH/YEAR from your business? (choose appropriate) DAY MONTH YEAR	4. How much were the operating costs related to your business? TSHS.

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SECTION H-1: WAGE JOBS

1. Did you do any wage work during the last 12 months? YES.....1 NO.....2	2. Who was an employer for the work? Central gv.....1 Local gv.....2 Parastatal.....3 Political party.....4 Cooperative.....5 NGO.....6 Religious org.....7 Private Sector.....8	3. Did you receive wages, salary or other payment in cash or kind YES.....1 NO.....2	4. If NO, what is the main reason for receiving no payments? Volunteer.....1 Compensation scheme....2	5. How were you paid? Hourly.....1 Daily.....2 Weekly.....3 Monthly.....4 Quarterly.....5 Half year.....6 Yearly.....7 Piecework.....8 CODE TSH	

SECTION I: HOUSEHOLD TOTAL INCOME

1. What is the total income earned by your household last season?	2. What were the source of households total income (off farm sources) Pensions..... salaries..... Seasonal wage..... Relative support..... Rent equipment Other activities (specify)	3. What were the sources of households total income (on farm sources) From cotton..... From other crops..... Others (specify).....	

SECTION J: FARMING CHALLENGES AND RECOMMENDATIONS

1. What challenges do you face regarding cotton production? [Tick the correct ones]

- i. High price of seeds ☐
 - ii. Poor quality of seeds ☐
 - iii. High production cost ☐
 - iv. High marketing cost ☐
 - v. Unreliable market ☐
 - vi. Unreliable weather ☐
 - vii. Delayed payment ☐
 - viii. Lack of inputs ☐
 - ix. Disease ☐
 - x. Poor infrastructure ☐
 - xi. Lack of market information ☐
 - xii. Increased competition level against competing commodities. ☐
 - xiii. Low fertility of soils ☐
- Other _____

2. What recommendations do you have on improving cotton productivity and efficiency?

- i. _____
- ii. _____
- iii. _____
- iv. _____
- v. _____
- vi. _____
- vii. _____
- viii. _____
- ix. _____
- x. _____

APPENDIX

Appendix 1: Stochastic frontier results for production function

Stoc. frontier normal/half-normal model	Number of obs = 128
	Wald chi2(3) = 381.21
Log likelihood = -947.81382	Prob > chi2 = 0.0000

totalcottonharvest	Coef .	Std. Err.	z	P> z
-----+-----				
PesticidTotalquantity	30.40888	8.118354	3.75	0.000
SeedTotalquantity	-13.29892	8.428191	-1.58	0.115
farmsize	409.0102	89.773	4.56	0.000
_cons	51.02936	87.76978	0.58	0.561
-----+-----				
/lnsig2v	11.56456	.2467879	46.86	0.000
/lnsig2u	11.92723	.4820157	24.74	0.000
-----+-----				
sigma_v	324.4975	40.04102		
sigma_u	389.0131	93.75521		
sigma2	256629.8	57887.78		
lambda	1.198817	125.0275		

Likelihood-ratio test of sigma_u=0: chibar2(01) = 3.46 Prob>=chibar2 = 0.031

Appendix 2: Stochastic frontier results for inefficiency variables

Stoc. frontier normal/half-normal model Number of obs = 128
Wald chi2(16) = 174.96
Log pseudolikelihood = 89.094969 Prob > chi2 = 0.0000

Inefficiency	Coef.	Robust Std. Err.	z	P> z
dextension	-.1085912	.0335283	-3.24	0.001
Ddiploma	-.0095682	.0917588	-0.10	0.917
DstdVII	-.0122331	.0343389	-0.36	0.722
Dcertificate	.1012637	.0807611	1.25	0.210
DformIV	.0034855	.0362796	0.10	0.923
Ddegree	-.0326739	.0421612	-0.77	0.438
Dsingle	-.0407024	.0535043	-0.76	0.447
Ddivorced	.4698674	.2272865	2.07	0.039
Dseparated	.0333238	.0693743	0.48	0.631
Dwidow	.0409778	.0456296	0.90	0.369
Dmale	-.0172255	.0431416	-0.40	0.690
lnage	.0217366	.0642054	0.34	0.735
lnHouseHsize	-.1366322	.0441063	-3.10	0.002
lnCctotal	.0870168	.0363243	2.40	0.017
lnIncometotal	-.0432611	.034103	-1.27	0.205
lnfarmexperience	-.0595596	.0313621	-1.90	0.058
_cons	.3593556	.5019352	0.72	0.474
/lnsig2v	-4.230048	.1330436	-31.79	0.000
/lnsig2u	-12.73558	.1531367	-83.16	0.000
sigma_v	.1206304	.0080245		
sigma_u	.0017159	.0001314		
sigma2	.0145546	.0019361		
lambda	.0142248	.0080063		

Appendix 3: VIF results

Variable	VIF	1/VIF
-----+-----		
lnHouseHsize	2.88	0.347604
lnfarmexpe~e	2.85	0.350531
lnCctotal	2.52	0.396600
lnage	2.52	0.396798
DstdVII	2.45	0.407395
lnIncometo~1	2.36	0.423869
DformIV	2.05	0.487322
Dmale	1.78	0.562418
Dsingle	1.73	0.578137
Dwidow	1.72	0.581564
dextension	1.51	0.663121
Ddiploma	1.42	0.702851
Dcertificate	1.27	0.786030
Dseparated	1.25	0.799559
Ddivorced	1.24	0.805517
Ddegree	1.13	0.882146
-----+-----		
Mean VIF	1.92	

Appendix 4. Results for Model specification test

inefficiency	Coef.	Std. Err.	z	P> z
_hat	.6641583	.5249317	1.27	0.206
_hataq	.481061	.7365749	0.65	0.514
_cons	.0540509	.1704046	0.32	0.751