ESTIMATING THE COST EFFICIENCY AND PROFITABILITY AMONG COTTON SMALLHOLDER FARMERS IN CHATO DISTRICT

BERINO MSIGWA

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ABSTRACT

Agriculture is an important sector in developing countries serving most people in rural areas as their main means of livelihood. About 84% of agriculture activities in Tanzania are done by smallholder farmers. Cotton is an important cash crop for many countries in the world. In Tanzania cotton is a major cash crop in the western cotton growing area, which includes Mwanza, Shinyanga, Mara, Simiyu, Geita, Tabora and Singida regions. The cotton subsector is known to involve expensive activities to be undertaken compared to other crops. Farmers in cotton farming areas are characterized by having limited access to inputs like fertilizer, pesticides and herbicides due to widespread poverty among them. For smallholder farmers to get profit from cotton production, efficiency in allocating their resources is crucial. The objective of this study was to assess whether cotton producers in Chato District get profit from cotton production and whether they produce at the minimum cost. A multistage sampling procedure was employed to select 150 respondents (134 males headed households and 16 female headed households) from Chato District. Descriptive statistics, net profit analysis and a Cobb Douglas stochastic frontier model were computed. The mean net profit realized was 454 422 TZS/ha. The minimum and maximum net farm income was -530 938 and 2 399 775 TZS/ha respectively. The results from quartiles range show that majority of famers are getting profit but the level of profit is different where others are getting lower profit or negative return. The return on investment was 0.86 shillings for every shilling invested. The study established that, all coefficients in the frontier model (quantity of cotton harvested, seed, pesticides, fertilizer, land rent and transport costs) have a positive sign indicating that as inputs, they have a positive influence on the total production cost. The results show further that, the mean cost efficiency of smallholder farmers in the study area was 2.9, the minimum cost efficiency observed being 1 and the maximum was 6.4. The inefficiency model revealed that, cost efficiency among farmers was positively influenced by farmers' education level, access to extension services, family size and membership in cotton growing associations.

DECLARATION

I, Berino Msigwa, do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted at any other institution.

_______________________ _______________________

Berino Msigwa **Date**

(MSc. Candidate)

The above declaration is confirmed by;

_______________________ _______________________

Prof. Aida C. Isinika **Date**

(Supervisor)

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DEDICATION

This work is dedicated to my Father, Martin Akilimali Msigwa and my mother, the late Angela Joakim Lupenza who together laid the foundation of my education. I also dedicate this work to my brothers and sisters who encouraged me and supported me during the entire study period.

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LIST OF ABBREVIATIONS AND ACRONYM

AMCOS	Agricultural, Marketing and Cooperative Society
ATC	Average Total Cost
BOT	Bank of Tanzania
COMESA	Common Market for Eastern and Southern Africa
CSDP	Cotton Sector Development Programme
DAICO	District Agriculture, Irrigation and Cooperative Officer
DCI	District Cotton Inspector
DED	District Executive Director
df	Degrees of freedom
ECGA	Eastern Cotton Growing Area
FC	Fixed Cost
FHH	Female Headed Household
GAFSP	Global Agriculture and Food Security Program
GAP	Good Agriculture Practices
GDP	Gross Domestic Product
GM	Gross Margin
Ha	Hector
ICAC	International Cotton Advisory Committee
KG	Kilogram
M.Sc.	Master of Science
MC	Marginal Cost
MR	Marginal Revenue
N	Sample size
P	Probability

Q	Quantity harvested
SD	Standard Deviation
SHF	Smallholder Farmers
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Science
SRSD	Simple Random Sampling Design
Std	Standard
t	t- value
TC	Total Cost
TCB	Tanzania Cotton Board
TFC	Total Fixed Cost
TGT	Tanzania Gutsby Trust
TOSCI	Tanzania Official Seed Certification Institute
TPRI	Tropical Pesticides Research Institute
TR	Total Revenue
TVC	Total Variable Cost
TZS	Tanzanian Shillings
UN	United Nations
UNECA	United Nations Economic Commission for Africa
URT	United Republic of Tanzania
USA	United States of America
VC	Variable Cost
VIF	Variance Inflation Factor
WCGA	Western Cotton Growing Area

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Agriculture serves as the mainstay for most people in developing countries and it is the only means of livelihood for most of rural communities' members (Girei and Dire, 2013). In Tanzania, the economy depends heavily on agriculture (crops and livestock), which accounts for about 23% of the GDP, provides 85% of export earnings, employs about 80% of the work force, and sustains the livelihoods of more than 75% of the entire population while providing about 95% of their food (URT, 2016, and GAFSP, 2016). In Tanzania about 84% of agriculture activities are done by smallholder farmers rather than large farms and estates, which account for only 16% of all agriculture activities. Smallholder farmers are characterized by having small farms (0.2-2 ha), low yields, high production costs and low net returns for all crops. The main traditional cash crops grown by smallholder farmers in Tanzania include coffee, cotton, sugarcane, cashew nuts, tobacco, sisal, pyrethrum, tea, cloves, oil seeds, spices and flowers (Asea *et al.*, 2014 and Derksen-Schrock *et al.*, 2011).

Cotton belongs to the *Gossypium* Species of the family Malvaceae being one of the cash crops grown in Tanzania. It is cultivated as an annual shrub with a single, ascending main stem that bears a leaf at each node and usually has one branch. Vegetative branches tend to be produced lower down on the plant, while reproductive branches are produced higher up. Cotton leaves are large, palmately lobed (three, five or seven lobed) and covered with multicellular stellate hairs. The plant bears showy flowers, each with five sepals united into a cuplike calyx and five petals of whitish or yellowish color that often turn pink with age (Directorate Plant Production, 2016).

Each seed of cotton is surrounded by a white downy fibre which is easily spun. The crop is domesticated mainly as a source of fibre. Known species of cotton include; *Gosypium hirsutum* L., *Gosypium barbadense* L., *Gosypium herbaceum* L. and *Gosypium arboretum* L. The species *Gosypium hirsutum* is the most commonly cultivated in Tanzania (TCB, 2010).

Cotton is an important cash crop for many countries in the world including Tanzania, where it is a major cash crop along with coffee, tea, tobacco, cashew nuts and sisal (TCB, 2010). In fact it is the largest export crop after tobacco, cashew nuts and coffee in terms of value (BOT, 2017). The crop also plays an important role in alleviating poverty among rural households. It is mainly grown on small scale farms ranging from 0.5 to 10 Ha and the average farm size being 1.5 Ha (GAFSP, 2016).

In Tanzania, there are two cotton growing regions, the Western Cotton Growing Area (WCGA) and the Eastern Cotton Growing Area (ECGA). About 99% of all the cotton produced in Tanzania comes from the Western Cotton Growing Area, which includes Mara, Mwanza, Shinyanga, Simiyu, Geita, Singida and Tabora regions. Only 1% of the cotton grown in Tanzania comes from the ECGA covering Iringa, Morogoro, Coast region, Tanga, Kilimanjaro and Manyara. A few regions of the South and Southern highlands, including Mbeya, Njombe, Ruvuma, Lindi, Mtwara and Rukwa have been quarantined. They are not allowed to produce cotton in order to prevent the spread of red bollworm from neighboring countries Malawi, Mozambique and Zambia (UN *et al.*, 2017 and TCB, 2010).

Global production of cotton is largely dominated by India (26%), followed by China (20%) and the United States of America (USA) (16%), where the three countries alone account for more than 60% of total global production of cotton fiber (ICAC, 2016). Tanzania accounts for around 0.5% of the world cotton production and about 7% of African production. Farmers in Tanzania employ low input levels; the majority using hand hoes while a small proportion use animal traction for tillage (Ngaruko and Mbilinyi, 2014). Depending on the total production, about 70-80% of the total cotton crop is exported, while the remaining crop is channeled to the domestic textile industry. Major markets for cotton from Tanzania include China, Indonesia, Thailand, Kenya, Portugal, Bangladesh, Vietnam and Pakistan (TCB, 2010).

As rational economic agents, cotton farmers in the WCGR strive to maximize profit from their farm operations, which entails cost minimization. In order to produce at minimum cost, farmers need to be cost efficient in allocating their scarce resources. Modeling cost functions is therefore an important step in providing advisory services to farmers as they strive to ensure the cost of production is minimized. Such that it is equal to or lower than the prevailing price of seed cotton, hence maximizing profit.

Decision making based on the output criterion requires that Marginal Cost (MC), which is the increase in total cost from producing one additional unit of output, should be equal to the Marginal Revenue (MR), which is the change in total revenue as a result of selling one additional unit of output. Marginal cost tells us how total cost changes as total product changes. Since profit is the difference between total revenue (TR) and total cost (TC), $\pi = TR - TC$, profit maximization therefore occurs at the output level “Q” where the gap between the two values is widest representing the biggest difference between total revenue and total cost as shows in Fig. 1.

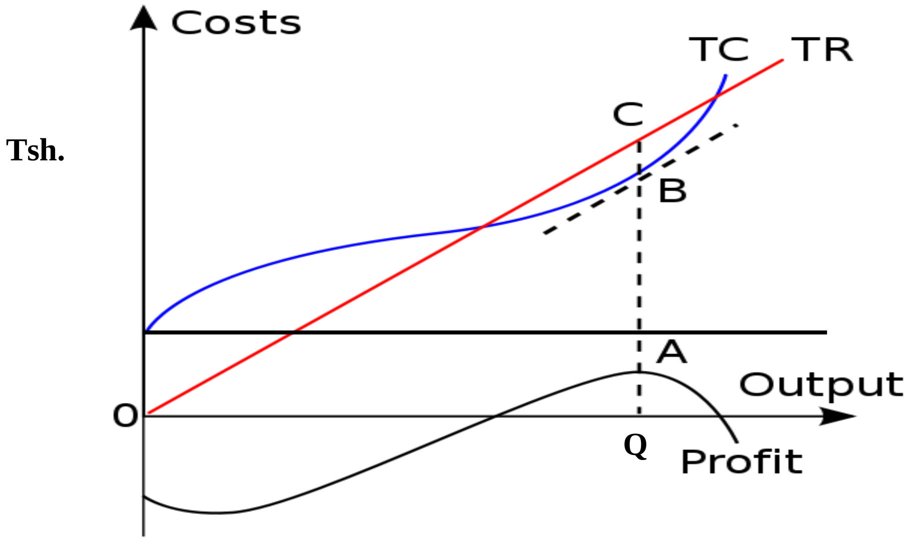

Figure 1: Total cost, total revenue, total fixed cost and profit curves

1.2 Problem Statement and Justification

The cotton subsector is known to be an expensive undertaking compared to other crops while at the same time farmers in the subsector are characterized by having limited access to inputs like fertilizer, pesticides and herbicides due to widespread poverty among them (TCB, 2010). According to TCB (2010), only 5% of farm preparations for the area under cotton production is done by motor traction like tractors, 60% is done using hand hoes and 35% is done using animal traction. Also about 70% of all cotton grown in Tanzania is produced without the application of fertilizer and only 30% is grown using organic or animal manure. Weeding and harvesting are entirely done manually using hand hoes and hand picking respectively. For cotton smallholder farmers to get profit from cotton production, efficiency in allocating their resources is crucial. Increasing cost efficiency could lead to an increase in income and profitability (Muhhamad *et al.*, 2011). Such improvement would be reflected as a lower average total cost curve or lower unit cost of production.

Cotton is an annual crop that requires substantial investment in labour, pesticides and fertilizer annually in order to achieve profitable yields (Mwangulumba and Kalidushi, 2012). Cotton is known to involve extensive and tedious farm operations, labour being a major input in the production process. Yilmaz *et al.* (2005) found that cotton is one of the highest labour demanding crop among all field crops produced in Turkey. In their cost analysis study, results showed that the net return per kilogram of seed cotton was insufficient to cover the cost of production. The most important cost items were labour, machinery, land rent and pesticide. The average units of labour used for cotton production were 739.7 hours per hectare, of which 21% was provided by family members. Ali *et al*. (2010) also found that due to high labour demand, over the years the cost of cotton production by smallholder farmers has been increasing at a rate that is higher than the increase in the product price. Inputs like fertilizer, insecticides and improved seed are also expensive, hence raising production cost further. As the production cost increases, the profit accruing to cotton farmers decreases, pushing them to shift away from the cotton industry to more rewarding alternative crops like sunflower and green peas (UN *et al*., 2017 and TCB, 2013).

This study focused cotton production in Chato District because it is one of the areas in Tanzania where cotton smallholder farmers are abandoning cotton production for alternative crops like sunflower (Mwangulumba and Kalidushi, 2012 and TCB, 2010). One of the reasons for such shift is presumed to be the high cost of production. Hence cotton is in danger of losing its popularity among smallholder cotton farmers in the study area.

This study is designed to estimate the cost efficiency and profit level of cotton smallholder farmers, in order to provide useful information to farmers and to Local Government Authorities in the study area on how to improve cotton production and profitability through cost minimization. The role of cotton for the growth of the agricultural sector is essential, since the crop contributes significantly to the country's foreign exchange earnings. The findings will also provide useful information, which can be used by the government in analyzing agricultural input and price policies in future. Also, cotton smallholder farmers will be in a position to know the average cost of cotton production, hence help them to make the right decisions during future production processes with a view of reducing average production cost.

1.3 Objectives of the Study

1.3.1 Overall objective

The general objective of this study is to assess whether cotton producers in Chato district minimize cost and hence realize maximum economic rent (profit) from cotton production.

1.3.2 Specific objectives

The study pursued three specific objectives as follows;-

i. To describe the socio-economic characteristics of cotton smallholder farmers in Chato District.

ii. To assess whether cotton farmers are getting profit, producing where MR = MC, thereby operating as rational economic agents.

iii. To estimate the cost efficiency of cotton SHF in the study area.

1.4 Research Question and Hypotheses

1.4.1 Research questions

In order to address the first specific objective, this study address one research question as follows;-

- What are the socio-economic characteristics of cotton smallholder farmers in Chato district?

The remaining specific objectives are addressed by research hypotheses as follows;-

1.4.2 Research hypotheses

In relation to the second specific objective, the null hypothesis states that; Cotton production is not a profitable venture for cotton farmers in the study area. This means profit that is derived from cotton farming is not significantly different from zero. The alternative hypothesis states that profit from cotton production is greater than zero. Mathematically, these hypotheses are presented in equations (1) and (2) below;

Ho$_2$: $\pi cf = 0$.. (1)

Ha2: $\pi cf > 0$.. (2)

Where,

$\pi_{cf} =$ Profit derived from cotton farming

In relation to the third specific objective, the null hypothesis states that; Smallholder cotton farmers in Chato District are cost efficient, while the alternative hypothesis states that; Smallholder cotton farmers in Chato District are not cost efficient. Mathematically, these hypotheses are presented in equations (3) and (4) below;

Ho$_1$: $C_E = 1$ .... (3)

Ha$_1$: $C_E \neq 1$.. (4)

Where,

C_E = Cost efficiency of cotton production measured in terms of percentage.

1.5 Organization of the Study

This thesis is organized in five chapters. The first chapter presents background information for the study covering the problem statement, justification of the study, objectives of the study, research question and the study's hypotheses. The second chapter reviews literature on cotton production, estimation of cost function and profit analysis. The review intends to elucidate cotton agronomy, different methods used in estimating cost function and how profit can be analyzed. The third chapter presents the methodology used to analyze data in order to address each specific objective. The fourth chapter presents results and discussion of findings while the fifth chapter presents conclusions and recommendations based on the study findings.

1.6 Shortcomings of the Study

The study encountered some shortcomings. The main shortcoming related to the failure of farmers to keep farm records such as the cost of various farm operations. To address this problem recall data was collected based on the farmers' memory. It was, however difficult to correctly estimate quantities and values of inputs that were used especially for family labour. It is important for farmers to keep records which can later on help to assess whether they are making profit out of cotton farming activity or not. Limited fund and time also posed a challenge in completing this study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definitions of Key Terms

2.1.1 Cotton agronomy

Cotton production is a capital and labour intensive crop. Profitable production depends on the ability of farmers to minimize production cost throughout the season. During the production process the correct timing of farm operations is also important to ensure maximum productivity and cost efficiency. Inputs must be applied at the right time and in the right quantity to meet the use at the peak period (Yilmaz *et al.*, 2005). Late supply of cotton seeds, late or poor application of agrochemicals, delayed or poor weeding and poor performance of other cultural practices such as thinning can negatively impact on yields, hence reducing profitability. Cotton is also vulnerable to pests and diseases resulting in significant use of agrochemicals which increase production costs. All these farm operations require family and hired labour to meet timely agronomic operations, hence contributing to increased production costs (Musara *et al.*, 2011).

2.1.2 Total production costs (TC)

The total cost of any enterprise is the sum of fixed plus variable cost, which are used in the production process. Knowledge about the production cost is useful in the decision making process at the farm level in order to guide investment decisions, sourcing inputs and services, introducing new product, guiding technological changes and for developing market strategies. Total production cost can be denoted as follows:-

TC = $VC + FC$……………………………………………………………………… (5)

Where,

TC = Total cost,

VC = Variable costs and

FC = Fixed cost.

2.1.3 Average total cost

Average total cost is the production cost per unit of output, computed by dividing the total fixed costs plus variable costs by the total number of units produced (total output). Lower average cost is a competitive advantage, which means that the production cost per unit output is low. It is also called the unit cost of production as denoted in equation 6.

$$ATC = \frac{TC}{y} \qquad (6)$$

Where,

ATC = Average Total Cost,

TC = Total production cost and

Y = Total quantity of output.

2.1.4 Labour costs

Labour costs describe all costs incurred by a farmer from the employment of labour to work on various farm operations. Labour costs are usually presented as cost per hour worked. The cost of labour is further broken into direct and indirect (overhead) costs. Direct costs include wages for employees that directly produce an intended product. Indirect costs are associated with supporting labour (simply is explained as the cost of labour which is used to support or make direct labour more efficient such as employees who maintain farm equipment and those providing security). For smallholder farmers indirect cost is not very common because of their small production scale.

2.1.5 Fixed costs (FC)

Fixed costs are incurred by the farmer whether production takes place or not. In the production of cotton, fixed cost include payments for land purchases as well as depreciation cost of farm machinery and equipment. These are expenses which must be paid by a farmer, independent of any farming activity that also does not change with an increase or decrease in the production area, the amount of output to be produced or that to be sold.

2.1.6 Variable costs (VC)

Variable costs vary with the level of output produced by the farmer. For cotton production, in a single production season variable costs might be thought of as the costs associated with the purchase of the variable inputs used to produce cotton. Examples of variable costs include the cost of purchasing inputs such as seed, fertilizer, herbicides, insecticides and labour costs. Variable costs increase or decrease depending on a farmer's production level; they rise as production increases and fall as production decreases.

2.1.7 Marginal cost (MC)

Marginal cost is defined as the change in total cost, or total variable cost resulting from an incremental change in output. It is the cost of producing one more unit of a product or good. Marginal cost represents the incremental cost incurred when producing additional units of a good or service. The marginal cost formula can be used in financial modeling to optimize the generation of cash flow and it can be denoted as follows;-

$$MC = \frac{\Delta VC}{\Delta y} \qquad (7)$$

Where,

ΔVC = Change in Variable Cost

Δy = Change in total output quantity

2.1.8 Marginal revenue (MR)

Marginal revenue is the additional revenue that will be generated by increasing product sales by one unit. It can also be described as the unit revenue from the last item generated and sold by the firm. A firm calculates marginal revenue by dividing the change in total revenue by the change in total output. Hence, the sale price of a single additional good or product will be equal to marginal revenue. Marginal revenue can be denoted as:-

$$MR = \frac{\Delta TR}{\Delta y} \quad \ldots\ldots (8)$$

Where,

MR = Marginal revenue

ΔTR = Change in total revenue and

Δy = Change in total output quantity.

2.2 Theoretical Framework

This study is guided by the theory of the firm, assuming a perfectly competitive factor and product market, which explains the principles by which a business firm decides how much output to produce, and how much inputs or factors of production will be used in order to minimize cost and maximize profit. In a competitive market the criteria for profit maximization state that if a firm chooses to maximize profit, it must choose a level of output where Marginal Cost (MC) is equal to Marginal Revenue (MR) and the Marginal Cost curve is rising (Debertin, 2012). According to Cowell (2004), a firm is a transformation unit, which converts input into output and while doing so, the firm management tries to create surplus value. This is the difference between the value of the product and the value of the factors of production. In a competitive market a firm aiming at profit maximization reaches its equilibrium only when it produces the profit maximizing output where MC = MR (Debertin, 2012).

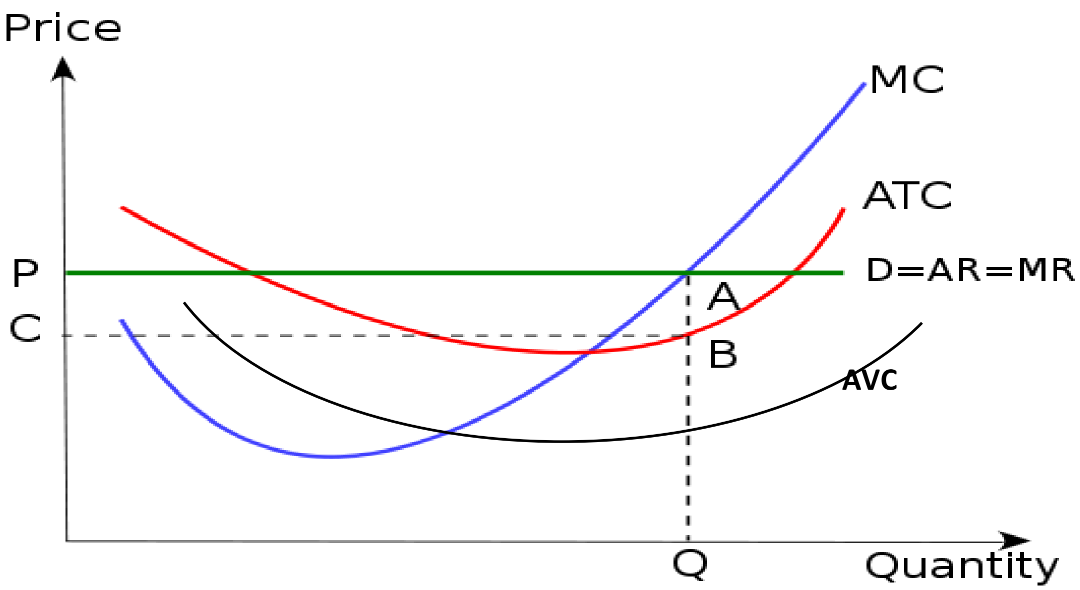

Figure 2: Proof of MC = MR = P as a profit maximization point

From figure 1, at point A, given the product price P, Marginal Cost = Marginal Revenue = Product Price, where revenue from each additional unit produced will be equal to the additional cost of producing it. For this to be attained the ATC level should be less than or equal to the product price (ATC ≤ MR = P). Also average variable cost (AVC) should be less than the average total cost (ATC) (Shahat, 2015). Thus, the optimum quantity should be produced at point Q where MC = MR = P_Q; ATC < MR and the level of profit will be equal to the rectangle PABC.

Aridah and Shaloof (2014), in their study on estimating the cost function of dates production in Murzuq, Southern Western Libya found that, by equating marginal costs, and the average product price in a competitive market, it is possible to obtain the output level that maximizes profit of dates. In another study on estimating the profit, cost functions, Economic and Technical Efficiency of Corn production in Babylon Province in Iraq, Al-Mansi *et al.* (2015) found that, maximum profit was obtained at the optimum production level and at the minimum total cost. Their analysis also revealed that there is a negative relationship between average production cost and profit, supporting the argument that the lower the AVC the higher the profit level. The result also showed that increase in product price leads to increase in profit, keeping other factors constant.

2.3 Analytical Issues

2.3.1 Assessing the profit level

While production cost is an important factor in determining profit, rational economic agents are driven by the profit motive to engage in various economic activities. In agriculture activities as in the case of all enterprises, minimizing production cost has the promise of higher net returns keeping other factors being constant. Profit is the return made in a business activity for the benefit of the business owner. The word “profit” comes from Latin meaning “to make progress.” Profit is defined in two different ways; one for economic and the other one for accounting purposes (Fáilte Ireland, 2013), as elaborated in the next section.

Pure economic profit refers to an increase in wealth from a certain investment, taking into consideration all costs associated with a given investment, including the opportunity cost of capital (Fáilte Ireland, 2013). Meanwhile, accounting profit can be defined as the difference between the product price and the cost of bringing that unit of output or service to the market (covering both operating cost and delivery cost). A firm is said to be making profit if revenue exceeds the total cost of production (Kumbhakar, 1994).

Various methods have been used to determine the level of a firm’s profit. Some of the procedures most frequently used include; computing the profit margin (net farm income), which takes into account variable cost and fixed cost. Another method is the gross margin analysis, which unlike the profit margin takes into account only the variable costs where fixed costs cannot be estimated. These two approaches are discussed further in the following section.

2.3.1.1 Profit margin

In any production process, various levels of inputs are employed to produce a given level of output. It is rational for farmers to allocate and utilize inputs at the minimum cost in order to maximize the level of profits accruing from such resources. Profit margins as stated earlier measure the profit of a firm by summing the fixed and variable cost items, and then subtracting the resulting total from gross returns obtained from selling crop or livestock produce. In most cases, farmers do not deduct the opportunity cost for their own money invested in farming. Moreover, they often ignore the cost of family labour as an expense. It is also argued that the profit figures which often appear on farming enterprises is more of return against operating expenses, excluding family labour cost (Debertin, 2002 and Odedokun *et al.*, 2015).

Odedokun *et al.* (2015) used the Net margin approach for their study on Economic Analysis of Cotton Production among Cotton Farmers in Northern Nigeria. Their result found that cotton production was a profitable venture in their study area. For every Nigerian Naira invested, farmers were able to get about 1.11 Nigerian Naira net returns. Alam *et al.* (2013) also conducted a study on “Economic Analysis of Cotton Production in Selected Local Government Areas of Taraba State, Nigeria”. Their results similarly showed that cotton production was a profitable enterprise where for every Nigerian Naira invested farmers were able to get about 0.56 Nigerian Naira as net return after deducting fixed and variable costs.

Net farm income gives the overall level of profitability of an enterprise. It involves the determination of gross or total revenue and gross or total costs. The difference between the two constitutes the net farm income. The net farm income technique is computed where the fixed cost of production can be determined (Babangida, 2016).

According to Firth (2002), the cost of field operations is often not accurately recorded on all farms. Hence they rely on estimates that may vary from farm to farm, which can cause wrong conclusions when comparison is made across farms. Net margins and net profit per enterprise are also less appropriate for farm planning, since the fixed cost elements are unlikely to vary directly in proportion to the size of the enterprise, therefore other techniques can be used like gross margin analysis.

2.3.1.2 Gross margin approaches

Unlike profit margin, Gross margin analysis does not take into account the fixed cost of production. Gross margin analysis forms an alternative basis to assess farm profitability. This method involves collecting data for the cost of variable inputs and the gross income obtained from a particular enterprise (Babangida, 2016). Essentially, gross margin is a budgeting tool for estimating total variable cost of production and revenue. Gross margin is determined by deducting variable costs from the gross income of a given crop or livestock within a given period of time. Output and cost vary with the scale of enterprises. It is therefore expected that if an enterprise grows, the gross margin per hectare will remain the same as long as the data used are normalized per unit area.

Gross margin allows the farmer to compare the relative profitability of alternative cropping options that have similar land, machinery and equipment requirements. Gross margin also indicates the cost of production of alternative enterprises, which may help the farmer to make farm management decisions and planning. This variable (GM) can be used to analyze the performance of individual enterprise and it helps to indicate areas where improvements can be made (Leslie, 2013). Gross margin analysis is less time consuming, which may save time and money, especially for enterprises with large inventory.

Profit is not proportional to gross margin. According to Philip (2016), gross margins do not take into account any changes that may occur in a fixed cost structure of the business. A gross margin analysis may show good results for one particular crop but not for another under similar conditions. Hence, the gross margin of an enterprise is not necessarily an indication of its profitability. Increasing the intensity of enterprises on a farm may increase the total farm gross margin, but it will not necessarily increase the farm profit since the fixed cost may also rise in greater proportion (Heaslip *et al*., 2013). For the case of this study profit margin was used because it was possible to determine the cost of fixed assets used in cotton farming.

2.3.2 Estimation of cost function

When considering cotton production as an activity for rural development, it is necessary to assess its cost efficiency. Different functional forms are used for estimating cost functions. These include the; Translog cost function, Cobb-Douglas cost function, quadratic cost function, data envelop analysis and others. Giroh *et al*. (2011) in their study on technical efficiency and cost of production among smallholder rubber farmers in Edo state, Nigeria they used a stochastic frontier cost function. They found that variation in technical efficiency and the cost of production among smallholder rubber farmers had a significant effect on the production efficiency which plays a big role in the variation of production cost. Their study concluded that farmers who were efficient in using resources were able to reduce production cost.

In another study Paudel and Matsuoka (2009), used a stochastic frontier cost function to analyze the cost efficiency of maize production in Chitwan district, Nepal, with the aim of predicting the economic efficiency of the production system. The maximum likelihood estimates of the parameters revealed that the estimated coefficients for tractors, animal power, labour, fertilizer, manure, seed and maize output had positive coefficients and they were significantly different from zero at the 5% level. This implies that the cost function monotonically increases with the increase in input prices. Further, quantitative estimates obtained from the cost function show a mean cost efficiency of 1.63 indicating that on average, maize farmers from the study area incurred about 63% costs above the frontier cost, an indication of cost inefficiency.

Meanwhile, Zavale *et al*. (2006) conducted a study to determine smallholder’s cost efficiency in Mozambique, where they estimated the cost function using a Translog stochastic cost function. Their estimates suggested that the relationship between the total variable cost and input prices were positive and statistically significant at the 5% level. Results from their study implied that, increasing efficiency in the allocation of inputs would lead to cost minimization, hence attaining profit maximization, which would encourage farmers to produce more. Similarly, Ngabitsinze (2014) in his study to analyze the economic efficiency of maize production in Huye District, Rwanda used a stochastic frontier cost function. He found that parameter estimates indicated a positive relationship between variables, and these were significant at the 10% level for fertilizer and labour. However the coefficient for maize output reflected a negative relationship that was significant at 10%, implying that farmers in the study area incurred higher cost for maize production by about 2.6% above the frontier cost which was an indication of inefficiency on cost management.

Maurice *et al.* (2014) in their study on the analysis of cost efficiency using the Maximum Likelihood procedure, stochastic cost function revealed that the explanatory variables for extension contact, crop diversification and credit availability were positive and significantly related to cost efficiency. This implies, it is possible to reduce production cost by increasing input cost efficiency.

Similarly, Hasan (2007), in his study to analyze the cost function of wheat farmers in Bangladesh using a stochastic frontier Cobb, Douglas cost function found that, the cost of seed, fertilizer and land rent had a significant effect on cost efficiency. An increase in the magnitude of these variables would result in a corresponding increase in the cost of producing wheat in the study area, thereby reducing profit. In the current study, a Cobb-Douglas cost function is used to estimate the cost efficiency of cotton smallholder farmers in the study area due to its ability to handle multiple inputs in its generalized form (Murthy, 2002).

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Conceptual Framework

The conceptual framework of this study is based on the argument that, achieving cost efficiency in cotton production can be influenced by Socio-economic characteristics of smallholder cotton farmers as well as input prices for cotton production (factor cost). Achieving cost efficiency will then lead to increase in profit levels accrued by farmers. A rational farmer strives to maximize profits, which also entails cost minimization, a necessary condition for cost efficiency. It is therefore assumed that the higher the unit cost of production, which can be due to inefficiency, the lower the profit level and in some cases loss or negative returns may occur.

It is assumed that in the study area farmers face different factor markets. Some farmers may minimize production cost more efficiently than others depending on their socio-economic characteristics and the factor cost they face. Efficiency may be achieved through input cost reduction strategies like negotiating for discounts when they buy inputs and being selective where they buy inputs from. Such savings lead to increased profit. Farmers who are not capable of using different strategies to reduce production cost, will produce at a higher cost leading to lower profit or they may even incur loss. The conceptual framework for this study is shown in Fig. 3.

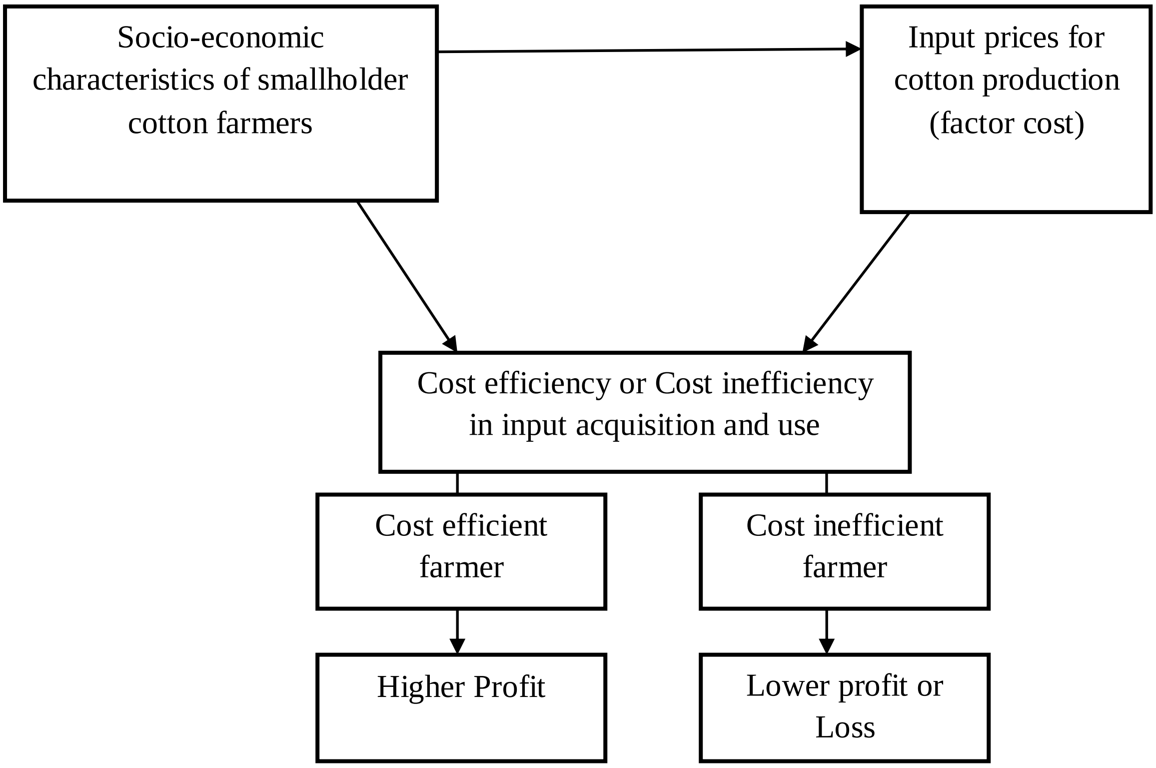

Figure 3: Conceptual framework for cotton production cost efficiency

3.2 Description of the Study Area

The study was conducted in Chato District, Geita Region in Tanzania. Formery Chato district belonged to Kagera region. It was reallocated to Geita region in March 2012. Geita is a new region formed in 2012 being located in the Western Cotton Growing Area which comprise of seven regions; Mara, Mwanza, Shinyanga, Simiyu, Geita, Singida and Tabora. Chato is among six districts in Geita Region where cotton is the main cash crop. Other Districts in Geita region include Bukombe, Mbogwe, Nyang'hwale, Geita and Geita Town council. The study focused in Chato District because it is one of the areas where cotton smallholder farmers are abandoning cotton production for other alternative crops like sunflower (Mwangulumba and Kalidushi, 2012 and TCB, 2010). One of the reasons for such a shift is presumed to be driven by the high cost of production for cotton. Hence, cotton is in danger of losing its popularity among smallholder cotton farmers in the study area.

Chato District is located between $2^0 15'$ – $3^0 15'$ South of Equator and 31^o – 32^o East of "Standard Meridian". It is within the altitude ranging between 1 135 – 1 410 M above sea level. It borders Muleba District to the North, Bukombe to the South, Biharamulo to the West and Geita to the East. The District covers 3 572 Km^2 of which 3 472 Km^2 is land and 100 Km^2 is covered by Lake Victoria. Chato District is subdivided into 5 divisions, 23 wards and 115 villages where 21 wards out of 23 produce cotton as their main cash crop.

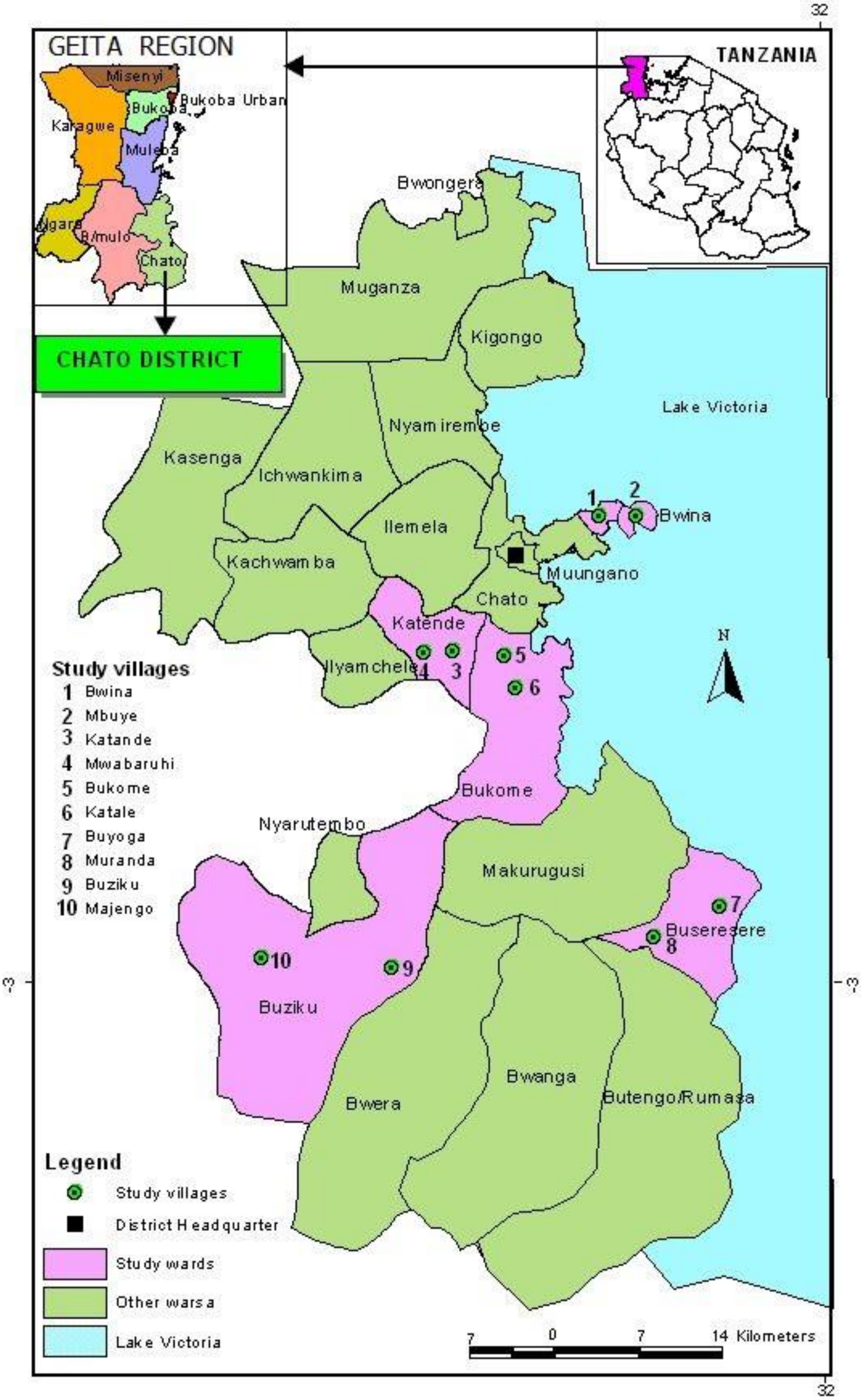

Figure 4: Map of Chato District showing geographical distribution of study wards and their respective villages

3.2.1 Climate

Chato District experiences bimodal rains, short rains fall from September to December and long rains fall from February to May. Rainfall is reliable ranging between 700mm in dry areas to 1 000 mm in wet areas with an average of 850 mm per annum. The District has a moderate temperature ranging between 26^{o}C to 30^{o}C. Both rainfall and temperature are influenced by the district's proximity to the equator and Lake Victoria. The soils in Chato District range from sand, sandy clay to clay loam soil, which are suitable for growing a varied range of crops including cotton (DED Chato, 2018).

3.2.2 Economic activities

The economy of Chato district depends primarily on agriculture, which contributes more than 73% of the District GDP. Similarly, about 77.2% of the labour force relies on agriculture for earning their living. Only 11.2% of the district residents are involved in non-agricultural activities (DED Chato, 2018). The main economic activities involve crop production, livestock keeping, fishing and mining. These are conducted at a large and small scale. Some residents also engage in small scale trade and petty business. Major food crops produced are cassava, maize, sweet potatoes, beans, finger millet, sorghum and rice. Cash crops include cotton, groundnuts and sunflower.

3.3 Research Design

This study adopted a cross sectional research design, where data was collected at a single point in time. The design was appropriate as it allowed for all required data to be collected at one point in time within three months. The survey was conducted between June 2018 and August 2018 by collecting primary data for cotton production from cotton smallholder farmers in the study area for the cropping season of 2016/2017. Secondary data were obtained from the District Executive Director's office, which provided more information related to cotton production in Chato district. Secondary data was collected from unpublished district sources; this included the number of cotton smallholder farmers in the district, the socio economic profile of Chato distric, the number of wards and their respective villages which produce cotton.

3.4 Sampling

3.4.1 Sampling frame

The population for this study consisted of all smallholder farmers in Chato District operating in 21 wards that produce cotton (see section 3.2). The sampling frame involved 12 915 cotton smallholder farmers who were registered by the Tanzania Cotton Board in collaboration with extension staff from Chato District Council.

3.4.2 Sample size determination

The sample size was selected based on the formula developed by Cochran (1977) and cited by Bartlett *et al.* (2001) as shown in equation 9 below;-

$$n = \frac{Z^2 pq}{e^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(9)}$$

Where,

n = required sample size

Z = confidence level at 95% (standard value of 1.96)

p = is the estimated proportion of an attribute that is present in the population (0.5)

q = 1-p and

e = margin of error at 5% (standard value of 0.05).

Based on equation 9, the sample size was computed to be 385. According to Bailey (1998), a sample or sub-sample of 30 respondents is the bare minimum for a study in which statistical data analysis and inference to the population can be done, regardless of the population size. Also, according to Matata *et al.* (2001), 120 is an adequate number of respondents for most socio-economic studies in Sub-Saharan Africa. Thus a sample of 152 respondents was selected for this study as a representative of the study area.

3.4.3 Sampling procedure

Accurate sampling is important for minimizing sampling bias in order to draw reliable inferences about the population. This study employed a multistage sampling procedure, combining non-probability and probability sampling techniques. In the first stage Chato district was purposively selected because it is one of the areas where it has been observed that cotton smallholder farmers are abandoning cotton production for alternative crops like sunflower due to the presumed high cost of production.

The second stage of sampling involved randomly selecting five wards out of 21 followed by random selection of two villages from each ward. The last stage involved random selection of 150 cotton smallholder farmers, sampled proportional to village size, depending on the number of cotton producers from each of the selected villages. During the sampling process all cotton smallholder farmers in the study area were assumed to be homogeneous. In addition two key informants; the District Agriculture, Irrigation and Cooperative Officer (DAICO) and the District Cotton Inspector (DCI) were purposively selected due to their experience and knowledge on cotton production in the district. The total sample comprised of 152 respondents as shown in the Table 1.

Table 1: Wards, villages and corresponding samples for each village

Ward	Village	Number of cotton SHF	Sample		
			Male	Female	Total
Bukome	Katale	238	22	1	23
	Bukome	237	20	3	23
Buseresere	Buyoga	30	3	0	3
	Muranda	45	4	0	4
Katende	Katende	268	23	3	26
	Mwabaruhi	150	11	3	14
Bwina	Bwina	263	20	5	25
	Mbuye	228	21	1	22
Buziku	Buziku	36	3	0	3
	Majengo	60	6	0	6
Total		**1555**	**134**	**16**	**150**

3.5 Analytical Models

3.5.1 Profit margin (Net farm income) analysis

In assessing whether cotton farmers in the study area operate as rational economic agents by producing where MR = MC, farm budgetary technique was used to analyze profit. Profit analysis is done by subtracting total production cost from total revenue as shown in equation 14.

$\pi_i = TR_i - TC_i$.. (14)

Where,

π = Profit

TR = Total Revenue

TC = Total Cost.

The analysis involved the determination of TR and TC for each farmer; these were later used to calculate profit for each farmer as shown in equation 15.

$TR_i = Q_i * P_i$.. (15)

Where,

TR = Total Revenue

Q = Quantity harvested

P = Price per kilogram

Also total cost was calculated by summing up all the cost used in the production of cotton in the study area as shown in equation 16.

TC = $\sum_{i=1}^{n} VC + \sum_{j=1}^{n} \text{FC}$ ………………………………………………………….. (16)

Where,

TC = Total Cost

TVC = Total Variable Cost

TFC = Total Fixed Cost

To determine the total fixed cost, annual depreciation was calculated using the straight line method based on the formula presented in equation 17.

$ADC = \frac{CA - SV}{ULA}$ ………………………………………..…………..………….. (17)

Where,

ADC = Annual Depreciation Cost

CA = Cost of the Asset (purchase price of the asset)

SV = Salvage Value of the Asset (value of the asset at the end of its useful life)

ULA = Useful Life of the Asset in years (number of periods in which the asset is expected to be used by a farmer)

After determining the profit level for each farmer, further analysis was conducted to determine the return for every shilling invested using the formula given in equation 18.

ROI = $\frac{TR-TC}{TC}$ ……………………………………………………………………… (18)

Where,

ROI = Returns On Investment

TR = Total Revenue

TC = Total Cost

Return on Investment (ROI) is a performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments.

3.5.2 Cobb Douglas stochastic cost frontier analysis

A stochastic frontier of the cost function has been independently proposed by Aigner *et al.* (1977). The original specification implies a cost function generated for a cross sectional data set, with two-component error terms, one relating to stochastic effects and the other related to cost inefficiency. This study used the stochastic frontier model according to Battese (1992), which defines the minimum cost for a given output level, input prices and existing production technology. Estimating the total cost function C(w, Y) required data on cotton production costs, outputs (Y) and cotton input prices (w) for Smallholder Farmers (SHF), whose behavior is assumed to be cost-minimizing. The parameters were estimated in a single stage by a Maximum Likelihood estimator using a Cobb-Douglas Stochastic Cost frontier model, which was specified as given in equation 10.

$C_i = f(Y_i, W_i, \varepsilon_i) + (V_i + U_i)$……………….…………..………………..………….. (10)

Where,

C = Total Cost of Production

Y = Output produced

W_i = Price of inputs

ε_i = Error term

f = Appropriate function

The empirical model was then double loged and normalized using labour wage to reduce data redundancy and increase consistency. Hasan, (2007) also used a similar method to estimate the total cost function for wheat production in Bangladesh as shown in equation 11.

$$Ln\left(\frac{Ci}{W1i}\right) = \alpha_0 + \alpha 1LnQi + \sum_{j=2}^{b} \alpha jLn\left(\frac{Wji}{W1i}\right) + (Vi + Ui) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Where,

Ln = Natural log

C_i = Total Production Cost per hectare for the i^{th} farmer, for i = 1, 2 ...n

W_{1i} = Price of labour input per hectare for the i^{th} farmer, for i = 1, 2 …n and 1 represent input labour)

α = Parameters to be estimated

W_{ji} = Price of j^{th} input per hectare for the i^{th} farmer, for i = 1, 2 …n and j = 2, 3…k

V_i = Random error associated with random factors which farmers have no control on it

U_i = Random error associated with farmers' inefficiency on input use

In order to get proper results, estimation of cost efficiency was also important in this study.

3.5.3 Estimation of cost efficiency

The cost efficiency of an individual farm was defined in terms of the ratio of the observed total cost of cotton production (C^b) to the corresponding minimum cost of cotton production (C^m) given the prevailing technology. A farmer having a cost efficiency of 1 defines a cost efficient farm. Determination of cost efficiency was done using the formula given in equation 12.

$$\frac{\mathbf{C^b}}{\mathbf{C^m}} = \mathbf{C^{EE}} \quad \text{……………………………..……..……………………………(12)}$$

Where,

C^b = Observed total production cost

C^m = Minimum cost of cotton production

C^{EE} = Cost efficiency in cotton production

It is also important to determine as to what extent farmer's specific variables influence inefficiency in allocating financial resource.

3.5.4 Cost inefficient effect model

In order to examine the effect of various relevant farmer specific variables on inefficiency, the cost inefficiency effect model was used. The inefficiency variables included in the model were respondents' age, education level, access to extension services, sex of respondents, family size and membership in cotton farming association. The model was then specified as presented in equation 13.

$$\mu_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + W_i \quad \text{………..……………….. (13)}$$

Where,

μ_i = Total cost inefficiency for the i^{th} farmer, for i = 1, 2 …n

Z_{1i} = Age of the i^{th} farmer

Z_{2i} = Education level of the i^{th} farmer

Z_{3i} = Dummy for access to extension services for the i^{th} farmer (1 = yes, 0 = No)

Z_{4i} = Dummy for sex of the i^{th} farmer (1 = Male, 0 = Female)

Z_{5i} = Family size of the i^{th} farmer

Z_{6i} = Dummy for membership in cotton farming association for the i^{th} farmer (1 = yes, 0 = No)

δ = Unknown parameters to be estimated

W_i = Unobserved random variables assumed to be independently distributed

The inefficient component (u_i) is associated with farmers' socio-economic factors that account for performance difference among farmers, hence leading to the differences in profit levels among farmers.

3.6 Data Collection

Primary data was collected in Chato District using a structured questionnaire administered to cotton farmers. Data collection took place between June and August 2018 using a structured personal questionnaire (Appendix 1). Primary information was collected on cotton output, farm specific factors, factor costs and socio-economic factors as shown on the empirical models presented in equations 11-18. These included, among others cotton output, amount of seeds, gender, age and experience. Data on values of output computed as the product of total output sold and the price while data on cost was computed as the sum of price of the inputs times the corresponding quantity and other operational cost incurred by a farmer. Secondary data including information on cotton production, cotton sales and the number of cotton farmers in the district were obtained from Chato District Council's Officers (DAICO), Sokoine National Agricultural Library (SNAL) in Morogoro and the Tanzania Cotton Board (TCB).

After collecting the data, primary data were organized, cleaned, summarized, coded and analyzed using statistical software including Excel, the Statistical Package for Social Science (SPSS version 20) and STATA version 13. Frequencies, means and percentages were used to indicate the relative strengths and distributions of respondents based of various variables. Descriptive statistics were employed to present output for quantitative and qualitative data. Analytical tools that were used for addressing the study objectives included the budgetary technique (profit analysis) and the stochastic frontier cost function as presented in section 3.5.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Social Economic Characteristics of the Respondent

Socio-economic characteristics of smallholder farmers are important for cotton farming in Chato District since the household is the decision making unit for all production matters. The socio-economic characteristics discussed in this section include, sex, age, marital status, education level, membership in the cotton growing association, household size, experience in cotton farming, farm size, access to extension services and participation on cotton production training. Results for social economic characteristics of respondents were used to address the first objective.

4.1.1 Sex of respondents

In Table 2, the findings show that more male headed households (89.3%) are engaged in cotton production in the study area compared to female headed households accounting for only 10.7%. The proportional of FHH in Lake Zone including Chato District was 24.6% for rural areas and 20% for urban areas. This proportion of cotton farming FHH is lower than that of proportion of Tanzania (25%) (FAO, 2014 and Tanzania Census, 2012). A lower percent of female head households producing cotton could imply that, they cannot afford the cost associated with cotton production. This was established from the study conducted by Sakamoto (2011), in South East Tanzania to find if female headed households are more vulnerable than men headed households. Sakamoto found that in Tanzania about 33% of households are female headed and 67% are male headed households. This finding is in line with a study conducted by UN *et al.* (2017) on "Improving the Value Added of Cotton byproducts in Eastern and Southern Africa" which found that out of 95 farmers interviewed in the survey, 85 (89.5%) were males while 10

(10.5%) were females. These findings also agreed with result by Alam *et al.* (2013) who established that the majority (89%) of the respondents in their study were males while about 11% were females indicating that there are more males in cotton production than their female counterparts being higher than corresponding proportions in the population.

Table 2: Distribution of respondents according to sex

Sex	Frequency	Percent
Male	134	89.3
Female	16	10.7
Total	**150**	**100.0**

4.1.2 Age of respondents

Age is a socio-economic attribute which reflects farmers' abilities and physical disposition in planning, organizing, controlling resources in order to accomplish production activities and other farm tasks. According to Table 3, the respondents' mean age was 47 and 51 years for males and females respectively implying that female respondents were slightly older. However the range of age was wider for male respondents compared to female.

Table 3: Age distribution of respondents disaggregated by gender

	Male		Female		Whole sample	
Age category	Frequency	Percentage (%) by sex	Frequency	Percentage (%) by sex	Frequency	Percentage (%)
<30	0	0.0	3	2.2	3	2.0
30 - 45	4	25.0	63	47.0	67	44.7
46 - 60	9	56.2	47	35.1	56	37.3
>60	3	18.8	21	15.7	24	16.0
Total	**16**	**100.0**	**134**	**100.0**	**150**	**100**

For male cotton smallholder farmers the maximum age was 80 years, the minimum age was 29 years with a standard deviation (SD) of 11.5 years. For female farmers the maximum age was 75 years, the minimum age was 30 years and SD was 11.4 years. But the distribution of age is similar since about 82% of male cotton smallholder farmers range from 30 to 60 years while the distribution of age for female cotton smallholder farmers shows that about 81% fall in the same age range. The results further show that, only 2.2% of male cotton smallholder farmers are less than 30 years old and 15.6% are above 60 years. For female farmers none were less than 30 years old while 18.7% were above 60 years. This shows that, since cotton farming has high labour demand, most participants are of middle age since they are capable of undertaking cotton production using family and hired labour (Ododekun *et al.*, 2015).

4.1.3 Marital status of respondents

The findings in table 4 show that, majority of cotton smallholder farmers in the sample are married. About 96.3% of the male cotton farmers are married while only 43.7% of female cotton farmers are married. The proportion of single respondents was 3.7% for males and 56.3% for females. Married cotton farmers account for 90.7% of all sampled respondents while 9.3% are single.

Table 4: Marital status of respondents disaggregated by gender

	Male		**Female**		**Whole sample**	
Marital status	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%)**
Single	5	3.7	9	56.3	14	9.3
Married	129	96.3	7	43.7	136	90.7
Total	**134**	**100.0**	**16**	**100.0**	**150**	**100**

The higher proportion of single respondents among FHH may imply that, they face labour constraints especially for activities such as spraying which mostly require male labour; such findings have been established by FAO (2011).

4.1.4 Education level for cotton smallholder farmers

The survey results show that, the majority of cotton smallholder farmers acquired primary education level as shown in Table 5. About 79.9% and 81.3% of male and female farmers respectively have primary education level.

Table 5: Education level distribution of respondents

	Male		Female		Whole sample	
Education level	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percent age (%)**
No formal education	10	7.5	2	12.5	12	8
Primary level	107	79.9	13	81.3	120	80
Secondary level	16	11.9	1	6.2	17	11.3
Tertiary level	1	0.7	0	0.0	1	0.7
Total	**134**	**100.0**	**16**	**100.0**	**150**	**100**

The results further show that for male respondents about 7.5% did not attend any formal education in their life time, 11.9% attended secondary education level and only 0.7% attended tertiary education. In the case of female respondents about 12.5% did not attend any formal education in their life time, 6.2% attended secondary education and none attended tertiary education level. According to these findings there is no much difference in the education attainment of male and female respondents.

4.1.5 Membership on cotton growing associations

According to results presented in Table 6, about 64.2% of male cotton farmers are members of cotton growing associations while 35.8% are not. The corresponding proportion for female farmers is 43.7% and 56.3% respectively. For the whole sample about 62% of all farmers in the sample are members of cotton growing associations. The results show that most farmers join cotton growing associations but the proportion is higher among male farmers (64.2%) compared to female farmers (43.7%). In the study area there are 29 active cotton growing associations called Agricultural Marketing and Cooperative Societies (AMCOS) which are accessible to all villages in the district.

Table 6: Distribution of respondents on membership in cotton growing associations

	Male		Female		Whole sample	
Membership	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%)**
Yes	86	64.2	7	43.7	93	62
No	48	35.8	9	56.3	57	38
Total	**134**	**100.0**	**16**	**100.0**	**150**	**100**

A farmer may choose to join any cotton growing association or they may not join any. The associations are used as centers for input distribution, buying cotton and centers as for farmers' training. So it is good for farmers to be a member (DED Chato, 2018). FHH may face constraints which reduce their ability to join these associations due to a poor awareness of the benefits or lack of time due to other household activities.

4.1.6 Household size of respondents

The majority 44.7% of all respondents in the study area had household size ranging from 6-10 members. About 46.8% of male headed households have household size ranging from 6-10 members. While only 11.1% of the female headed fall within the same range.

Table 7: Household size distribution by gender of household heads

	MHH			FHH	Whole Sample	
Household size	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%)**
1-5	34	24.1	5	55.6	39	26.0
6-10	66	46.8	1	11.1	67	44.7
11-15	33	23.4	2	22.2	35	23.3
16 - 20	7	5.0	1	11.1	8	5.3
>20	1	0.7	0	0.0	1	0.7
Total	**141**	**100.0**	**9**	**100.00**	**150**	**100**

The maximum number of household members was 24, the minimum number was one, the mean was nine with a standard deviation of 4.2. For female headed households the maximum number of household members was 17, the minimum was one, the mean was seven with a standard deviation of 4.7. The maximum number of members for the whole sample was 24, the minimum was one, the average was nine and SD was 4.2 for all respondents sampled in the study area. These results imply that the distribution of household size is skewed to the left (not normally distributed).

4.1.7 Experience in cotton farming

Results in Table 8, show the distribution of cotton smallholder farmers based on the farming experience on cotton farming. The results show that about 34.7% of all respondents have over 20 years of experience in cotton farming. However the proportion is higher (37.5%) among male farmers compared to female farmers (34.3%).

Table 8: Distribution of farming experience

	Male		Female		Whole sample	
Experience (yrs)	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%)**
<5	23	17.2	6	37.5	29	19.3
5-10	28	20.9	3	18.8	31	20.7
11-15	19	14.2	0	0.0	19	12.7
16-20	18	13.4	1	6.2	19	12.7
>20	46	34.3	6	37.5	52	34.6
Total	**134**	**100.0**	**16**	**100.0**	**150**	**100**

The minimum years of cotton farming experience was 1 year, the maximum was 50 years, and the mean was 17 years with standard deviation of 12.6. Results also show that male farmers had a maximum experience of 50 years, a minimum of 1 year, a mean of 17 years and standard deviation of 12.2. Female farmers had a maximum experience of 46 years, a minimum of 2 years, a mean of 16 years with a standard deviation of 15. Using an independent t-test, results show that there is no significant difference in mean experience between household heads at the 5% level of significance. Based on these results, it can be concluded that, the mean years of experience for male smallholder farmers and female smallholder farmers are more or less the same.

4.1.8 Farm size cultivated with cotton

The land size of the respondents cultivated cotton varies from 0.1 hectare to 4.8 hectares, with minimum size being 0.1 hectare, a maximum of 4.8 hectares, a mean of 0.96 hectares with a standard deviation of 0.71 as shown in Table 9. The majority of respondents, 94% comprising of 83.33% male and 10.67% female farmers cultivated cotton on farms ranging from 0.1 to 2 hectares.

Table 9: Distribution of farm size cultivated with cotton by gender

	Male		Female		Whole sample	
Farm size (ha)	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percent age (%)**
0.1-2	125	93.3	16	100.0	141	94.0
2.1- 4	8	5.9	0	0	8	5.3
4.1-6	1	0.8	0	0	1	0.7
Total	**134**	**100.0**	**16**	**100.0**	**150**	**100**

Male farmers had a maximum of 4.8 hectares, a minimum of 0.1 hectare, a mean of 1 hectare with a standard deviation of 0.73. In contrast female farmers had smaller farms with a maximum of 1.6 hectares, a minimum of 0.2 hectares, a mean of 0.6 hectares and a standard deviation of 0.4 hectares. Furthermore, all female household heads cultivated less than 2 hectares, while their counterpart cultivated up to 4.8 hectares. Based on the independent t-test, there is a significant difference in the mean cultivated area between male cotton farmers and female farmers at the 5% level of significance. Based on these results it can be concluded that, male household heads had higher mean farm size cultivated than female household heads. These results are similar to those of a study conducted by Babangida (2016), which showed that majority of the respondents, had farm size ranging from 0.5 to 2.5 ha.

4.1.9 Participation in cotton growing training

Table 10 shows results of farmers' participation in training for farming production. Different agriculture stakeholders have conducted training for farmers in the study area. These stakeholders include;

- Tanzania Cotton Board (TCB)
- Tanzania Official Seed Certification Institute (TOSCI)
- Tropical Pesticide Research Institute (TPRI)
- Cotton Sector Development Programme (CSDP)
- Tanzania Gatsby Trust (TGT)
- Quton
- Ukiriguru Research Institute and
- The Ministry of Agriculture.

Table 10: Participation in cotton growing trainings aggregated by gender

	Male		Female		Whole sample	
Trainings	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%) by sex**	**Frequency**	**Percentage (%) by sex**
Yes	44	32.8	3	18.8	47	31.3
No	90	67.2	13	81.2	103	68.7
Total	**134**	**100.0**	**16**	**100.0**	**150**	**100**

The results indicate that 68.7% of all respondents did not participate in any training. About 67.2% of the male farmers and about 81.2% of female farmers did not participate in any training on cotton production. Participation in most training sessions is voluntary and free for all farmers; however most of them do not participate demanding to get paid during training (DED Chato, 2018). This means the majority of farmers do not think the training is useful for them. There is no variation in the proportion of male and female household heads in terms of their respective participation in training.

4.1.10 Access to extension services

Extension services are considered important sources of information in agriculture activities including cotton production. In the study area cotton farmers expect to get extension services only from government staff. Table 11 shows the distribution of respondents by their access to extension services.

Table 11: Access to extension services

	Male		Female		Whole sample	
Access to extension services	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
Yes	90	60.0	6	4.0	96	64
No	44	29.3	10	6.7	54	36
Subtotal	**134**	**89.3**	**16**	**10.7**	**150**	**100**

Results show that, 64% of all cotton smallholder farmers had access to extension services. Out of 134 male farmers 67% had access to extension services while out of 16 female only 37.5% had access to extension services. Further analysis using the chi-square test show that, accessibility to extension services is significant between male and female household heads at the 5% level of significance.

4.2 Profitability Analysis

Cotton farmers are driven by the profit motive to engage in cotton production. Cotton is a cash crop that is commercially produced primarily for sale. Since cotton harvested cannot be used for other purposes like food, animal feeds or any other use. This means a cotton production enterprise can be seen as an economic unit organized by farmers purposely to generate profit. Based on this premise, the expected net farm income is an important factor when farmers are planning at the farm level. The aim of profitability analysis was to address the second specific objective which intended to assess whether cotton farmers are getting profit by operating as rational economic agent. This analysis focuses on the cost incurred for inputs.

4.2.1 Specific inputs used in cotton production

Specific inputs used in cotton production included labour, fertilizer, seeds and agrochemicals. Labour was found to be the most important input since each activity needs labour. Both hired and family labour was assumed to be perfectly substitutable. Most small farmers do not pay the labour cost per man day; rather labour cost is paid per piece of land. Discussion with farmers revealed that the largest proportion of labour inputs was devoted to picking, land preparation and spraying.

Seed was also found to be a fundamental input for cotton production. The seed variety and quality may determine the final productivity of the crop. The average seed rate was approximately 25 kg/ha. Cotton seed was sold by Tanzania Cotton Board at 700 TZS/kg. The findings show that, smallholder farmers do not use inorganic fertilizers at all only a few farmers 16.7% use small quantities of organic fertilizer especially farm yard manure (FYM). However agro-chemicals or pesticides were used by a higher proportion of farmers being 91.7% for male headed households and 62.5% for female headed households. Pesticides were provided and sold by the Tanzania Cotton Board at a price of 5 000 TZS per hectare pack. The recommended dosage of pesticides is 3 hectare packs (three applications of pesticide in a hectare) prior to harvesting. The use of these pesticides tends to reduce cotton infestations hence higher quantity of cotton can be harvested increasing profit.

4.2.2 The costs of producing cotton

In order to realize profits from cotton production there is a need to minimize cost incurred in production. The cost used in cotton production include all costs incurred on variable inputs such as seed, fertilizer, labour, agro-chemicals, land rent, transport cost and depreciation on fixed or working assets possessed by the farmers. In order to get the value of fixed assets, depreciation was calculated so as to reflect the total cost of production as shown in Table 12.

Table 12: Average costs per hectare associated with cotton production

	Male		Female		Whole sample	
Variable input employed	**Cost (TZS)**	**Percentage (%)**	**Cost (TZS)**	**Percentage (%)**	**Cost (TZS)**	**Percentage (%)**
Seed	28 529	5.5	15 012	4.9	29 235	5.6
Pesticide	29 760	5.7	7 750	2.6	28 035	5.3
Fertilizer	10 805	2.1	31 250	10.0	10 708	2.0
Transport	23 944	4.6	9 624	3.2	22 030	4.2
Labour	355 520	68.8	197 187	63.1	360 125	68.5
Depreciation						
Depreciation	12 845	2.5	5 262	1.7	14 595	2.8
Land rent	55 992	10.8	45 312	14.5	61 238	11.6
Total	**517 395**	**100**	**312 397**	**100**	**525 966**	**100.0**

The average cost of producing one hectare of cotton for male headed households TZS 517 395 while for female headed households was 312 397.The average cost for the whole sample was TZS 525 966. Labour input accounted for about 68.8%, 63.1% and 68.5% for male headed households, female headed households and whole sample respectively of the average cost per hectare associated with cotton production. This is a clear indication that most cotton production activities on farms, especially for smallholder farmers are labour intensive and labour accounted for more than half of the average costs in cotton farms.

These results are supported by Yilmaz *et al.* (2005) who found that cotton is one of the most labour demanding crop among all field crops produced in Turkey compared to other crops.

About, 5.5%, 4.9% and 5.6% of costs were incurred on cotton seed for male, female and whole sample respectively while 5.7%, 2.6% and 5.3% represented the cost of pesticides for controlling pests and diseases. Fertilizer accounted for about 2.1%, 10% and 2% respectively of the cost for cotton production while 4.6%, 3.2% and 4.2 was used for transport. Depreciation of tools (eg. ox ploughs, hoes, slashers and bush knives) and land rent charges accounted for about 2.8% and 11.6% of the total cost of production per hectare respectively for whole sample. Female headed households incurred low depreciation cost of 1.7% which can be due to poor little ownership of fixed assets.

The findings as presented in Table 16 show that a minimum that cost a cotton smallholder farmer incurred was 180 273 TZS/ha while the maximum was 1 187 658 TZS/ha, an average of 525 966 TZS/ha with a standard deviation of 181 327 for the whole sample. For male headed households the maximum production cost incurred was 1 187 658 TZS/ha, a minimum of 180 273TZS/ha, a mean of 539 102TZS/ha with a standard deviation of 189 822. Results show that female headed households incurred a maximum of 830 937TZS/ha, a minimum of 191 800TZS/ha, a mean of 456 822TZS/ha with a standard deviation of 153,145. Female headed households incur lower production cost because their average farm size was also smaller compared to male headed households.

Table 13: Distribution of average cost per hectare on cotton farms

Range of cost	Male TZS/ha	Female TZS/ha	Whole sample TZS/ha
Mean	539 102	456 822	525 966
Minimum	180 273	191 800	180 273
Maximum	1 187 658	830 937	1 187 658
Standard Deviation	189 822	153 145	181 327.1

4.2.3 Profit estimation

The profitability of an agricultural production enterprise is defined as total farm income realized from output harvested minus total cost incurred in the production process. In this study, land was taken as a fixed input and data were expressed in per hectare basis. Variable costs that were estimated include input costs, fixed asset costs (annual depreciation) and total revenue realized for each sampled respondent. The cost and returns associated with the production of one hectare of cotton are described in Table 14.

Table 14: Cost and returns associated with cotton production

	Male		Female		Whole sample	
Item description	**Average amount/ha**	**Value (TZS/ha)**	**Average amount/ha**	**Value (TZS/ha)**	**Average amount/ha**	**Value (TZS/ha)**
Cotton yield	831kg	997 200	693kg	831 600	817kg	980 400
Variable inputs						
Seeds	41	28 529	21	15 012	25kg	29 235
Pesticide	1.9	29 760	0.52	7 750	4.25L	28 035
Fertilizer	202	10 805	6.25	31 250	475kg	10 720
Transport	L/sum	23 944	L/sum	9 624	L/sum	22 030
Labour	L/sum	355 520	L/sum	197 187	L/sum	360 125
Fixed inputs						
Depreciation	L/sum	12 845	L/sum	5 262	L/sum	14 595
Land rent	L/sum	55 992	L/sum	45 312	L/sum	61 238
Net farm income						
Profit	L/sum	479 805	L/sum	519 203	L/sum	454 422
Return per TZS		0.92		1.66		0.86

The analysis showed that, the quantity of cotton harvested ranged from 98 kg per hectare to 2 208 kg per hectare with an average of 817 kg/ha and with a standard deviation of 411.75 for the whole sample. Results show that male headed households harvested a maximum of 2 707 kg/ha, a minimum of 95 kg/ha, an average of 831kg/ha with a standard deviation of 412. For female headed households, the maximum quantity harvested was 1 500 kg/ha, a minimum of 195kg/ha, an average of 693kg/ha with a standard deviation of 392. The price for cotton sold was 1 200 TZS/kg. The mean net farm income was 479 805 TZS/ha, 519 203 TZS/ha and 454 422 TZS/ha for male headed households, female headed households and the whole respectively. The minimum and maximum net farm income was -530 938 and 2 399 775 TZS/ha for the whole sample respectively.

Further analysis show that female headed households earned a higher profit of 519 203 TZS/ha compared to male headed households who earned a profit 479 805 TZS/ha. From this result it can be concluded that majority of farmers in Chato District are making profit from cotton production while few of them operate at loss. Return on investment was 0.92, 1.66 and 0.86 for each shilling invested by male headed households, female headed households and whole sampled farmers respectively. Results show that for each shilling invested female headed household got 1.66 shillings on return compared to male headed households who got only 0.92 a shilling on return.

Test of hypothesis on profit (H_{02})

Test of the hypothesis for profit associated with cotton production was then carried out based on the net farm income estimates of the parameters in Table 15. The essence of testing the hypothesis is to confirm if the average profit accruing by male headed households, female headed households and the whole sample are significantly different from zero. Also to test if the profits accruing by male headed households are significantly different from those accruing by female headed households. The null hypothesis states that, cotton production is not a profitable venture in the study area i.e. $Ho_2: \pi cf = 0$. The test was performed by one sample t-test for male headed households and female headed households, results indicated that computed *t*-values were 13.95 for whole sample, 3.94 for female headed households and 13.37 for male headed households which all exceeded the *t*-critical value at 1% level of significance. Based on this result was concluded that the average profit accruing by male headed, female headed households and the whole sample is significantly different from zero and farmers are getting positive rent from cotton production.

Table 15: Statistical significance test of profit associated with cotton production

Estimates	Male	Female	Whole sample
Profit	479 805	519 203	454 422.00
Standard error	64 412	43 809	14 361.41
t-value	13.37 ***	3.94***	13.95***
df	133	15	149
N	134	16	150

*** = Significant at P<0.01

The results are similar to those of Mafuse *et al*. (2012) who conducted a study on the comparative analysis of profitability on cotton production under contract and non contract farmers in Zaka District Zimbabwe. They established that, non contract farmers were more profitable than contract farmers but they all making positive rent.

The findings are also comparable with Alam *et al.* (2013) which clearly indicated that cotton production was a profitable venture for many farmers in many places. Not only that, but also Masingi (2015), on his study on analyzing the performance of cotton smallholder farmers under contract farming in Bariadi district found that, cotton production was a profitable venture both for contract farmers and non contract farmers. It was further found that, on average contract farmers achieved a profit of 220 099 TZS while non-contract farmers achieved a profit of 153 588 TZS per acre and the difference in profit levels was significant at 5% level of significance. That study recommended increasing the provision of quality extension services, training, developing roads, market infrastructure, and provision of affordable credit to improve production and hence profit of cotton smallholder farmers.

4.4 Results from Econometric Model

4.4.1 Test for model stability

Prior to running the Stochastic Frontier cost Function, the explanatory variables were checked for the existence of multicollinearity and heteroscedasticity before interpreting the model's explanatory power, and significance of the model coefficients.

Multicollinearity arises when at least one of the explanatory variables is a perfect linear combination of the others. The existence of multicollinearity may cause the estimated coefficients to have low *z* values leading to erroneous conclusions. Multicollinearity was tested using the variance inflation factor (VIF). As a rule of thumb, if the VIF for a variable exceeds 5, then multicollinearity exists. The mean VIF value of explanatory variables was 1.744 indicating that there are no signs of multicollinearity as shown in Appendix 2.

Also, cross sectional data are usually plagued by the problem of heteroscedasticity. This statistical deficiency has implications on the results of regression models. The assumption of homoscedasticity of residuals (ε_i) is likely to be violated if they do not have a constant variance (var $\varepsilon_i \neq$ var ε_s); and the estimated parameters are inefficient, though they are consistent (Green and Hensher, 2009). The presence of heteroscedasticity in the model was tested using a scatter plot of Pearson residuals and fitted values of predicted variables. Results showed that heteroscedasticity is not a serious problem.

4.4.2 Results from Stochastic Frontier cost Function

Maximum likelihood estimates for coefficients of the stochastic Cobb Douglas cost frontier model, showing the minimum cost performance are presented in Table 12. The maximum likelihood estimates (MLE‟s) of the stochastic frontier cost function revealed that the estimated variance parameter, sigma squared (σ^2) was (2.8). The value was significantly different from zero at 1% level of significance. This indicates goodness of fit of the data for a specific model and the correct distribution assumption of the composite error term in the model.

Table 16: Parameters Estimates of Cobb-Douglas Stochastic Cost Frontier Model

Independent Variable	Parameter	Coefficient	Standard Error	Z-Value
Constant	α_0	0.95518***	0.322486	2.96
Ln Quantity harvested	α_1	0.186357***	0.052627	3.54
Ln Seed cost	α_2	0.403631***	0.044768	9.02
Ln Pesticide cost	α_3	0.173017***	0.030964	5.59
Ln Fertilizer cost	α_4	0.034792	0.023342	1.49
Ln Land rent	α_5	0.006114	0.029439	0.21
Ln Transport cost	α_6	0.041338**	0.021126	1.96
Variance parameters				
Sigma squared	δ^2	2.8182***	0.316128	8.91
Gamma	γ	0.659602***	0.351807	4.720
Log likelihood	LLF	-51.8277		

=Significant at 5% and *=Significant at 1%.

The model statistics Gamma (γ) as reported in Table 12; is the proportion of the total variance of the observed output from the frontier attributable to technical inefficiency. Gamma takes values between zero (0) and one (1) (Coelli, 1996). The estimated gamma parameter (γ) of 0.65 was highly significant at 1% level of significance thus indicating that about 65% of the variation in the total cost of production among the sample farmers was due to differences in their cost efficiency. The log likelihood function of (-51.82) expresses the goodness of fit of the model. This vector represents the value that maximizes the joint densities in the estimated model.

According to results presented in a table, all coefficients for the quantity of cotton harvested, seed, pesticides, fertilizer, land rent and transport costs have a positive sign indicating that they have a positive influence on the variation total production cost as expected. These results are similar to those of a study conducted by Paudel and Matsuoka (2009) to estimate the cost efficiency of maize production in Nepal. The results imply that increasing the magnitude of these variables will lead to a corresponding increase of of total production cost. Also, since the coefficients of input cost including seed, pesticide, and fertilizer are positive, it shows that the estimated cost function increases monotonically with input prices as asserted by Ogundar *et al.* (2006).

Similarly the findings by Hasan (2007) show that the coefficients for the cost of seed, pesticides and land rent are positive, implying that they influence the total production cost positively. The coefficients of cost of seed and land rent were significant at 10% and 5% levels of significance respectively.

The quantity of cotton harvested per hectare has a positive coefficient of 0.186 which is significant at the1% level. This means the total production cost has a direct relationship with quantity produced. The observed coefficient means that, a 1% increase in the quantity of cotton produced per hectare, will lead to an increase of approximately 0.2% of the total production cost per hectare. This result is comparable with a study by Hassan, (2007) who estimated the total cost function of wheat production by using a Cob-Douglas stochastic cost frontier model and Ogundar *et al.* (2006) who estimated the cost efficiency of maize production in Nigeria.

Similarly the coefficient of seed cotton has a positive sign (0.404) which is significant at the 1% level of significance. According to these results a 1% increase of seed cost per hectare leads to an increase of approximately 0.4% in the total production cost of cotton per hectare. This means, as the cost of seed per hectare increases, the total production cost per hectare also increases since the cost of seed is an integral part of the total variable cost for cotton production. Therefore an increase in seed cost tend to reduce the difference between total revenue and total cost hence reducing the expected profit. The results are similar to those by Ali *et al.* (2010) who conducted a study on Economic Analysis of Input Trend in Cotton Production process in Pakistan. Their results revealed that the cost of seed had a positive and significant relation with the total production cost and were significant at the 5% level of significance. The results further revealed that the high cost of seed tends to increase the total variable cost thereby reducing profit.

Results for pesticide costs have a positive sign with a coefficient of 0.173 which is significant at the 1% level of significance. According to these results a 1% increase of the pesticide cost per hectare will increase total production cost of seed cotton by approximately 0.2% per hectare. Pesticide application is an essential activity for cotton production since the crop is susceptible to pests and diseases.

The coefficient for fertilizer is positive as expected (0.035) but insignificant with P-Value of 0.136. The result implies that, if the cost of fertilizer increases by 1%, the total production cost will also increase by 0.035% per hectare. The value of fertilizer is not significant because majority of cotton smallholder farmers in the study area do not use fertilizer where only about 16.7% use fertilizer especially organic fertilizer and those who do probably apply sub-optimal levels. The result are consistent with those of Ogundar *et al.* (2006) who found that as fertilizer cost increases, total production cost increases too. Fertilizer is known to enhance crop productivity if used effectively at optimum levels. These results are also in line with those of Paundel and Matsuoka (2009), who found that the cost of fertilizer has a significant influence in the total production cost in their study area at 1% level of significance.

The coefficient for transport is also positive as expected (0.041) and it is significant at the 5% level of significance. If transport cost is increased by 1% the total production cost of seed cotton could rise by 0.04% per hectare. This result is similar to those by Hasan (2007) who established that increase of transport cost during production process, increases the total production cost. For cotton production transport cost includes; the cost of transporting inputs to farms and output products from the farms to selling points. So high transport cost will lead to increased total variable cost as a result, reducing the expected revenue or profit.

The coefficient for land rent is positive (0.006), as expected with a P-value of 0.835 which is not statistically significant. This implies that an increase in land rent cost will raise total production cost per hectare by 0.006%. The result for land rent to be not significance may be due to the fact that, the majority of cotton smallholder farmers in the study area are not renting land as they own their own pieces of land.

4.5 Estimation of Cost Efficiency

Results in Table 17, show the distribution of the cost efficiency among cotton smallholder farmers in Chato district. For any given technology, the cost efficiency of an individual cotton farm is defined as the ratio of the observed cost (C^b) to the corresponding minimum cost (C^m), where the observed cost (C^b) represents the actual production cost where as the minimum cost (C^m) represents the frontier total production cost or the least total production cost level. Cost efficiency takes the values between 1 or higher with 1 defining a cost efficient farm while values above one represent farms that are not cost efficient (Ogundari *et al*., 2006).

The predicted cost efficiency as presented in Table 17, ranged from 1.0 to 6.4. The mean cost efficiency of an average cotton farm was estimated at 2.9 for the whole sample, meaning that on average cotton farms in the study area incurred costs that are about 190% above the minimum cost defined by the frontier. The higher value of cost efficiency represents the more inefficient farmer during the course of cotton production. The frequency of the cost efficiency scores range between 1.0 and 1.2 representing about 5% of the sampled farmers, implies that very few farmers are fairly efficient in producing at the given level of output using the cost minimizing input ratios. This implies that, on average farmers in the study area are not cost efficient in allocating fund resource during cotton farming process.

On average male headed households had a mean cost efficiency of 2.9, a minimum of 1, a maximum of 6.3 with a standard deviation of 1. Female headed households had a mean cost efficiency of 2.5, a minimum of 1.6, a maximum of 4.1 with a standard deviation of 0.6. These results imply that on average male headed households was more efficiency in allocating fund resources than female households. According to results no female farmer attained a cost efficiency of 1 meaning that all female farmers were incurring costs above minimum cost defined by the frontier in cotton production.

In order to improve the efficiency of cotton production in Chato district the majority of farmers (95%) should be guided by extension agents to reduce the waste of resources associated with cotton production process in order to attain maximum profit levels (Makoko, 2013).

Table 17: Distribution of cost efficiency for cotton farmers

	Male		Female		Whole Sample	
Cost efficiency	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
1.0 – 1.2	7	5.2	0	0	7	5.0
1.3 – 1.4	2	1.5	0	0	2	1.0
1.5 – 1.6	4	3.0	0	0	4	2.5
1.7 – 1.8	3	2.2	1	6.3	4	2.5
1.9 – 2.0	3	2.2	2	13	5	3.0
2.1 - 2.2	15	11	3	19	18	12.0
2.3 – 2.4	12	9	2	13	14	9.0
2.5 - 2.6	10	7.5	2	13	12	8.0
2.7 - 2.8	11	8.2	2	13	13	9.0
2.9 - 30	9	6.7	1	6.3	10	7.0
3.1 - 3.2	15	11	0	0	15	10.0
3.3 –3.4	7	5.2	2	13	9	6.0
3.5 - 3.6	7	5.2	0	0	10	7.0
3.7 - 3.8	3	2.2	0	0	3	2.0
3.9 –4.0	3	2.2	0	0	7	5.0
4.1 - 4.2	6	4.5	1	6.3	6	4.0
4.3 - 4.4	5	3.7	0	0	3	2.0
4.5 - 4.6	0	0	0	0	2	1.0
4.7 - 4.8	3	2.2	0	0	3	2.0
4.9 and above	3	2.2	0	0	3	2.0
Total	**134**	**100**	**16**	**100**	**150**	**100.0**

Further the results using the t-test showed that, there is significant difference between cotton smallholder farmers' cost efficiency at the 5% significance level. This implies that, farmers in the study area are not cost efficient in allocating fund resource during cotton farming process. Given the results on the distribution of cost efficient among cotton farmers, it is also important to determine the factors affecting cost inefficiency.

4.6 Determinants of Cost Inefficiency

In determining factors influencing cost inefficiency, the inefficiency component of the error term u_i was regressed against respondents' age, education level, sex of respondents, access to extension services, family size and membership on cotton farming associations. These variables were thought to influence respondent's observed cost inefficiency deviating from the potential output level. The coefficients of farmers' education level, access to extension services, sex of respondents, family size and their membership on cotton farming associations have a negative sign as expected.

The results for determinants of cost inefficiency are presented in Table 14. The coefficients for education level and family size were significant at 5% level of significance and coefficients for access to extension services and membership on cotton growing associations were significant at 10% level of significance. This implies that there is an inverse relationship between these variables and cost inefficiency such that; an increase in their magnitude will decrease farmers' inefficiency. The coefficient for age and sex of respondents were not significant implying that they had no significant influence on farmers' inefficiency.

According to Nyagaka *et al.* (2010) and Amaza *et al.* (2006) their studies found that, as farmers' education level and access to extension services increases their ability to plan and use scarce resources also increases. Farmers with more education level are expected to be more efficient than those with lower levels of education. Not only that, but also family size of farmers determines the man power to be deployed in the farm and hence practicing good agricultural practices. Also being a member in cotton farming association increases chances of getting agricultural services on time and hence increasing efficiency.

Table 18: Parameters Estimates for Cost Inefficient Model

variable (Coefficient)	Expected sign	Coefficient	Standard error	Z-Value	P>|Z| (Significance)
Constant (δ_0)		-6.016***	2.151	-3.180	0.001
Age of respondents (δ_1)	-	0.034	0.025	1.380	0.167
Education level (δ_2)	-	-0.013**	0.090	-0.140	0.048
Access to extension services (δ_3)	-	-1.030*	0.727	-1.420	0.056
Sex of respondent (δ_4)	-/+	-0.029	0.888	-0.030	0.973
Family size (δ_5)	-	-0.020***	0.055	-0.370	0.012
Membership in cotton farming association (δ_6)	-	-0.750*	0.569	-1.320	0.087

*=Significant at 10%, **=Significant at 5% and *** = Significant at 1%

The findings also show that, the coefficient for farmers' age, has positive sign which is contrary to expectation and not significant. It was expected that, as farmers' age increases, cost inefficiency had to decrease due to the fact that they have good experience in cotton farming. These results are supported by a study conducted by Msuya and Ashimogo (2005), on the estimation of technical efficiency for sugarcane production in Tanzania.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The objective of this study was to assess whether cotton smallholder farmers in Chato District get profit (positive economic rent) from cotton production and whether they produce at minimum cost hence cost efficient. The specific objectives of this study were to describe the socio-economic characteristics of cotton smallholder farmers in Chato District, to assess whether cotton smallholder farmers in the study area are getting profit by operating as rational economic agents. Hence another objective of the study was to estimate the cost efficiency of smallholder farmers to asses if they were maximizing profit while minimizing cost.

Results of profit margin analysis showed that, on average farmers get a profit of 454 422 TZS/ha. The minimum net farm income was -530 938 TZS/ha which imply that some farmers got loss on cotton production. The maximum net farm income was 2 399 775 TZS/ha indicating that some farmers got higher profit than others. Also result show that, both female headed households and male headed households were getting profit from cotton production. Male headed households got a profit of 479 805 TZS/ha while female headed households got a profit of 519 203 TZS/ha which were slightly higher than that of male headed households. These results mean that majority of famers are getting profit but the level of profit is different where others are getting lower profit or negative return. It was therefore concluded that cotton production is a profitable enterprise for most farmers with an average return on investment of 0.86 shillings per shilling invested for whole sample. Male headed households had a return on investment of 0.92 shillings per shilling invested while female headed households had a return on investment of 1.66 shilling per shilling invested. Results show that female headed households have higher return on investment than male headed households. The farmers who are getting lower profit or negative return may be due to cost inefficiency. This may be due to lower levels of education, poor access to extension services, lack of man power and not being members of cotton farming associations.

Results from the stochastic frontier cost model showed that, the quantity of cotton harvested, cost of seed, cost of pesticides and transport cost had positive coefficients which were significant, implying that the increase of magnitude of these variables will lead to a significant increase in total production cost. The coefficients for fertilizer and land rent were positive but insignificant implying that increase of magnitude of these variables will increase total production cost by insignificant percent.

The results also showed that, majority of cotton smallholder farmers accounting for 95% are not cost efficiency as they produce with cost efficiency higher than 1. This means that, these farmers incur cost that is higher than least cost which reduces profit. The minimum cost efficiency observed was 1 and the maximum was 6.4 indicating inefficiency in allocating resources was high among farmers, and when the values of cost efficiency is above one, it represents farms that are not cost efficient.

Moreover, the coefficients of farmers' education level has negative sign as expected implying that as education level increases the level of cost inefficiency decreases. Access to extension services has a negative sign as expected implying that as access to extension services reduces cost inefficiency to farmers. Family size and being a member of cotton farming associations have also negative sign as expected, implying that there is an inverse relationship between these variables and cost inefficiency. This means that as a farmer gets more of these variables, cost inefficient in cotton production decreases.

The coefficient of age has a positive sign but not significance implying that there is direct relationship with cost inefficiency. As a farmer gets older cost efficiency increases but insignificantly. The coefficient of sex of respondents has negative sign but not significant meaning that a farmer being a male or female had no significant influence on cost inefficiency.

5.2 Recommendations

The results show that some farmers are incurring a loss in the cotton production enterprises due to cost inefficiency and about 95% of famers are not cost efficiency. Factors like education level, access to extension services, family size and membership to cotton growing associations were found to have a significant positive effect on reducing production cost inefficiency. It is therefore recommended that;

- The government and other cotton subsector stakeholders should improve the farmers' access to education, extension services and encourage farmers to join associations for easier accessibility of different agriculture services.

- The government and other cotton subsector stakeholders should provide modern farm implements, machinery and technology to help farmers minimize production cost hence increasing cost efficiency.

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APPENDICES

Appendix 1: Questionnaire

SOKOINE UNIVERSITY OF AGRICULTURE
SCHOOL OF AGRICULTURE ECONOMICS AND BUSINESS STUDIES
DEPARTMENT OF AGRICULTURE ECONOMICS AND AGRIBUSINESS
QUESTIONNAIRE FOR SURVEY STUDY ON ESTIMATING THE UNIT COST OF PRODUCTION AMONG COTTON SMALLHOLDR FARMERS IN CHATO DISTRICT

A. INTRODUCTION

1. Ward: ………………………………….. 2. Village: ………………………………..

3. Enumerator name ………………………………………………………………………..

4. Respondent's name…………………... 5. Date of interview……………………………

6. Phone number of respondent …………………………………………………………

B. GENERAL HOUSEHOLD SOCIO ECONOMIC CHARACTERISTICS

1. Name of the Household head……………………………………………………
2. Sex of the household head, Male [ ] Female [ ]
3. Age of the Household head (years)……………………………………………
4. Marital status, Single [ ], Married [ ], Widow [ ], Divorced/separated [ ].
5. Highest level of education, No formal education [ ], Primary level [ ], Secondary level (ordinary) [ ], Secondary level (advanced) [ ], Tertiary level [ ].
6. Family size (Number of family members)………………………………………….
7. How long have you been growing cotton/Experience in cotton production (years)…
8. Is there any growing society in your village? Yes [ ], No [ ]
9. Are you a member of cotton growers association? Yes [ ], No [ ].
10. Do you have access to extension services/contact with extension officers to demonstrate the effective use of inputs? Yes [ ], No [ ].
11. Is there an extension officer in your village? Yes [ ], No [ ].
12. If yes in Question 9 above how frequent? During farm preparation [ ], During planting [ ], During weeding [ ], During pesticide application [ ], During harvesting [ ]. **Note** multiple answers are allowed.

13. Have you ever attended cotton production trainings? Yes [ ], No [ ].

C. COTTON FARMING INFORMATIONS

14. Is agriculture your primary activity? Yes [ ], No [ ]. If NO what is your primary activity? Trade [ ], Livestock keeping [ ], Employed [ ], Others (specify)…………
15. How much land was used for cotton production on 2016/2017 season (Ha) ……
16. Is the land used for cotton cultivation owned? Yes [ ], No [ ]
17. Who supervises cotton farming activities in the family? ………………….
18. How much money was used for labour in the area under cotton cultivation in Tshs?
    a. Land preparation cost ……………………….………
    b. Planting cost……………………………….………
    c. Weeding cost…………………………...………
    d. Pesticide application cost…………………………….
    e. Harvesting cost………………………………………….
    f. Other (specify) ………………………………………….

    Total labour cost…………………………………………
19. How much of the following inputs were used in your cultivated land for cotton production?
    a. Seeds (kg) ……………………………………………………………….
    b. Pesticides (Lts) 1. ……………………………

       2. …………………………….
    c. Fertilizer (kg) …………………………………………………….
    d. Other (specify) ……………………………………………………..
20. Where did you buy these inputs?
    a) Seeds …………………………………………………………………….
    b) Pesticides……………………………………………………………
    c) Fertilizes…………………………………………………………….
    d) Others ……………………………………………………………………..
21. Fertilizers used were there organic or inorganic [ ] Organic, [ ] Inorganic
22. How much money was used for the following activities during cotton production?
    a. Cost of seeds………………………………………………….....
    b. Cost of pesticides……………………………………………..
    c. Cost of fertilizer……………………………………………

d. Cost of renting land…………………………………………………………

e. Transport cost……………………………………………………………

f. Other (specify) …………………………………………………………..

Total cost used was……………………………………………………

23. What were the fixed assets/implements used for cotton production and their costs?

a. Hand hoes [ ] @ Tshs …………………….

b. Oxen plough [ ] @ Tshs ………………….

c. Bush knives [ ] @Tshs ……………………

d. Sprayers [ ] @Tshs ……………………….

e. Slashers [ ]@Tshs ………………………..

f. Others (specify) [ ] @Tshs……………….

Total fixed cost……………………………

24. How many kilograms of seed cotton were harvested in the area? ....

25. What was the price of seed cotton per kilogram in Tshs? ……………………

D. CHECKLIST FOR KEY INFORMANTS (DAICO & COTTON INSPECTOR)

26. How many cotton farmers associations in the District and how do they operate?

…………………………………………………………………………………

……………………….……………………………………………………

27. What are the responsibilities of these associations in Question 26?

………………………………………………………………………………

…………………………….………………………………………………

28. Do you think why some cotton farmers in Chato District abandon from producing cotton and move for other crops?

………………………………………………………………………………

………………………………………………………………………………

29. Are cotton inputs reaching farmers on time and at right quantities to satisfy all farmers in the villages? Yes [ ], No [ ]. If No, what efforts are being done/ to be done to make sure farmers are getting inputs on time and right quantities

…………………………………………………………………………………

…………………………………………………………………………

30. What do you think has to be done so as to improve the production of cotton in Chato District/ encourage more farmers to engage in cotton production?

…………………………………………………………………………………………
………………………………………………………………………………

31. Apart from LGA, which other stakeholders/institutions are providing training to cotton smallholder farmers in Chato District?

………………………………………………………………………………………
………………………………………………………………………………………

THANK YOU FOR YOUR TIME

Appendix 2: Results for Variance Inflation Factor (VIF)

Variable name	**Variance Inflation Factor (VIF)**
Seed costs (Tshs)	1.879
Pesticides cost (Tshs)	1.669
Fertilizer cost Tshs)	1.372
Land rent (Tshs)	1.223
Transport cost (Tshs)	1.701
Cotton harvested (Kgs)=Q	2.618
Mean VIF	**1.744**