AN ESTIMATION OF TECHNICAL EFFICIENCY IN TANZANIAN SUGARCANE PRODUCTION: A CASE STUDY OF MTIBWA SUGAR ESTATE OUTGROWERS SCHEME

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

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ABSTRACT

This study describes the technical efficiency of sugarcane production and the factors affecting this efficiency. The study was conducted in Turiani Division, Mvomero District, Morogoro Region, Tanzania. Specifically, the study determined and compared the level of technical efficiency of outgrower and non-outgrower farmers, and examined the relationship between levels of efficiency and various specific factors. A cross sectional single-visit survey that included randomly selected representative samples of 69 outgrower farmers and a cohort of 71 non-outgrower farmers residing in the area surrounding the Mtibwa Sugar Estate (MSE) was conducted during October and November 2002. A pre-tested questionnaire was used to interview the farmers. To estimate technical efficiency analysis was done using a (FRONTIER Version 4.1) computer program for stochastic frontier production and cost function estimation developed by Coelli, (1996). Technical efficiency was estimated using the Cobb-Douglas production frontier assumed to have a truncated normal distribution. The results of the estimation showed that there were significant positive relationships between age, education, and experience with technical efficiency. Based on the findings, the study puts forward three major recommendations: First, pairing less experienced farmers with more experienced farmers, perhaps in some form of apprenticeship, would enhance the rapid exchange of experience and information. Second, new forms of information delivery need to be applied. Finally the possibility of encouraging collective sugar processing among private cane producers need to be explored. These measures could significantly improve the overall technical efficiency of outgrowers.

DECLARATION

I, Elibariki Emmanuel Msuya, declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and has not been submitted for a degree award in any other University.

Signature .....

Date .....12th November 2003.

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DEDICATION

To my wife Roslyn, you are missed dearly. May the Lord God rest Your Soul in Eternal Peace. Amen.

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LIST OF ABBREVIATIONS AND ACRONYMS

CERAF	Centre for Economic Research on Africa
CEPA	Centre for Efficiency and Productivity Analysis
DEA	Data Envelopment Analysis
EPTD	Environment and Production Technology Division
ESRF	Economic and Social Research Foundation
GDP	Gross Domestic Product
ILRI	International Livestock Research Institute
KSC	Kilombero Sugar Company
KSL	Kagera Sugar Estate Limited
MAFS	Ministry of Agriculture and Food Security
ML	Maximum Likelihood
MOA	Mtibwa Outgrowers Association
MSE	Mtibwa Sugar Estate
NDC	Netherlands Development Cooperation
NEI	Netherlands Economic Institute
OLS	Ordinary Least Squares
SAP	Sectoral Activities Programme
SNAL	Sokoine National Agricultural Library
SUDECO	Sugar Development Cooperation
SUA	Sokoine University of Agriculture
TPC	Tanganyika Planting Company Limited

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The plantation as a system of large-scale farming, still occupies a central role in the agricultural sector of Tanzania, particularly in the cultivation, processing and export of cash crops. Plantations play a major role in foreign exchange earnings. The plantation sector contributes more than 55 % of the national foreign earnings (Msambichaka and Bagachwa, 1986). In Tanzania, plantation agriculture is mainly identified with five important export crops, namely, sisal, sugar, tea, coffee and tobacco in order of increasing importance (Maganya, 1990).

At present, the sugar industry is one of the largest agro-processing industries in Tanzania. It contributes approximately 35 percent of the gross output of the food-manufacturing sector and some 7 to 10 percent of total manufacturing value added, (National Development Cooperation [NDC], 1992). The sugar industry is also a major employer with a labour force of about 20 000 including casual labour for cane cutting. According to Netherlands Economic Institute (NEI) (1991), the sugar industry can be considered economically beneficial for Tanzania and it contributes favorably to the country's balance of payments situation.

Sugarcane is prominent among Tanzania's plantation crops and is one of the most important industries in the country in terms of employment and foreign exchange earnings. The sugarcane plantations are categorised into two major production sectors, the estate sector and the outgrowers sector.

The outgrowers were able to produce 245 274 metric tonnes which is about 28 percent of total production of sugarcane in 2000/2001 season (Economic and Social Research Foundation [ESRF], 2002). There are signs that the estates can increase production. The Minister of State in the President's Office (Planning and Privatization) told the Parliament on June 2002 that Tanganyika Planting Company Limited (TPC) and Mtibwa Sugar Estate (MSE) have doubled sugar production after privatization in 1994 (Daily News, 2002).

It is necessary to compare the performance of outgrowers' to that of estates because it is generally perceived that outgrowers have small overhead costs, and also that most of the outgrowers' farms are in new lands that are more fertile. According to Mbilinyi and Semakafu (1995), MSE was expected to increase output from outgrowers during the 1990s as one way of achieving full capacity utilization of the factory. This would have been achieved because apart from outgrowers fields being more fertile they have better water supply being situated between the mountains, as compared to the estate farms, located down in the valley where it is drier. Hence, it is reasonable to suggest that outgrowers should be given priority as far as the development of sugar industry in Tanzania is concerned.

It should also be noted that there are many dependants who directly or indirectly depend on the outgrower schemes. Therefore, apart from enhancing production, improving the living conditions of the outgrowers will significantly enhance the development of a sizable fraction of the population of the (Morogoro) region where outgrower schemes operate.

1.2 Problem statement and justification

Although the sugar industry has grown since the privatisation of the estates, the industry has been facing severe problems during the last decade. Some of these problems are; declining production and productivity, increasing cost of production due to increase in input prices for fertiliser, pesticides, farm implement etc., fall in export prices and increased competition from cheap, imported sugar (Senkondo, 1988; Rawlins, 1989; Senkondo and Ashimogo, 1991; Sprenger, 1991; Mbilinyi and Semakafu 1995; and ESRF, 2002).

The management of MSE and Mtibwa Outgrowers Association (MOA), with the help of the Ministry of Agriculture through its extension workers, have tried to solve these problems in order to improve its' performance. Some of the efforts included provision of education to outgrowers (through extension services), advocating higher tax on imported sugar, provision of improved planting materials and replanting and gap filling.

Despite these efforts, the performance of the outgrowers was not satisfactory. It can be seen in Appendix 1 that the percentage contribution of the outgrowers has been

fluctuating in the past decade and dropping since 1998/99 season. Although according to Mbilinyi and Semakafu (1995), the average yield is 32.2 tons per hectare, the yield tends to vary enormously among outgrowers. For example, in Mtibwa division the yield varied from 12 tons to 70 tons per hectare.

In addition, the relatively high growth rate of the outgrowers and the estates seen after privatisation of the estates was mainly achieved through expansion of the cultivated area (opening new farms) rather than through increase in productivity of factors of production. This pattern of growth can no longer continue because of the declining land frontier and intolerance to any further environmental degradation especially, deforestation. Therefore, a new strategy for developing this industry should put emphasis on increasing sugarcane productivity.

In view of the declining competitiveness of the domestic sugar industry due to increasing imports, and high production costs, production efficiency will become an important determinant of the future of the industry in Tanzania. Developing and adopting new production technologies can improve productive efficiency. This is difficult at present due to limited income and credit to the outgrowers. Therefore, the industry can maintain its economic viability only by improving the efficiency of the existing operations given currently available technology.

So far no/little efforts have been undertaken to quantitatively study the efficiency levels of existing sugarcane technologies with a purpose of identifying ways of improving efficiency. The estimation of efficiency will enhance identification of the sources where

improvement can be made. The relationship between efficiency and specific factors can also provide useful policy information. This study attempts to fill this gap by examining the technical efficiencies of outgrower farmers and non-outgrower farmers. Non-outgrower farmers were included because cane production is fairly elastic – higher prices encourage outgrowers to grow more cane while lower prices discouraged them (ESRF, 2002). Previous evidence shows that with fertile soils and good weather, farmers can also easily switch from one crop to another (ESRF, 2002). It is envisaged that the findings and information from this study will draw lessons that can be supportive of efforts aimed at improving conditions of the outgrowers who are among the major shareholders of the sugar industry in Tanzania. Furthermore, it is hoped that the findings will contribute to a better understanding of technical efficiency of outgrower farmers and non-outgrower farmers in Turiani division.

1.3 Objectives

1.3.1 General objective

The main objective of the study is to estimate the technical efficiency of the sugarcane farmers and determinants of technical inefficiency in Turiani division.

1.3.2 Specific objectives

This study has three specific objectives : -

i). To determine and compare the levels of technical efficiency of outgrower and non-outgrower farmers;

ii). To identify the factors causing technical inefficiency of the outgrower and non-outgrower farmers by examining the relationship between efficiency level and various specific factors;

iii). To consider implications for policy and strategies for improving sugarcane production efficiency and for further research;

1.4 Hypotheses

This study builds on two basic hypotheses.

i). There is no significant difference in technical efficiency between outgrowers and non-outgrowers.

ii). Socio-economic and demographic variables such as age, education, etc. have no significant influence on the level of technical efficiency for both outgrowers and non-outgrowers.

These hypotheses stem from the expectation that the outgrower scheme stresses on use of new farming techniques and modern inputs. Therefore, we expect that the outgrower farmers achieved a higher level of technical efficiency than did non-outgrower farmers. That is

$$Ho: U_{io} < U_{in}$$

Where "o" indicates the outgrowers group and "n" indicates the non-outgrowers group. It must be remembered that U_i (the measure of technical efficiency) is the negative one-sided component of the total variance, and really shows the extent to which an individual farm's product falls below the group production frontier (Rawlins, 1989).

1.5 Definition of terms

a) Technical efficiency is concerned with maximization of output for a given set of resource inputs and indicates how far the firm/farmer can increase its output without absorbing further resources (Admassie and Matambalya, 2002; Piesse and Colin, 2000; Shenggen, 1999).

b) Outgrower farmer means any contracted cane grower in the vicinity of a sugar factory who grows sugar cane for sale to the sugar factory and is registered by the Sugar Board of Tanzania through outgrower associations (such as the Mtibwa Outgrowers Association, MOA) (Sugar Board of Tanzania, 2002).

c) Non-outgrower farmer means any non-cane grower in the vicinity of a sugar factory who grows other crops e.g. rice for home consumption and for sale (Sugar Board of Tanzania, 2002).

d) A contracted farmer is any farmer who has made an agreement to grow a specific crop or crops for a buyer (Eaton and Shepherd, 2001)

1.6 Organization of the thesis

This thesis is organised into five chapters including this introduction. The remaining chapters of the thesis are arranged as follows; the second chapter is a review of relevant literature. The methodology is explained in chapter three. Chapter four gives the results and discussion of the study. Concluding remarks and policy recommendations are narrated in chapter five.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 Overview

In the medium and long-term, agriculture will continue to play a central role in Tanzania's economy. The agricultural sector accounts for 50% of the country's gross domestic product (GDP), it constitutes 60% of the export earnings and it employs 84% of the work force (Ministry of Agriculture and Food Security [MAFS], 2002). Crucial components of the agricultural sector are food crops, livestock, and traditional exports whose contribution currently stands at respectively 55%, 30% and 8% of the total agricultural GDP (MAFS, 2002). The plantation as a system of large-scale farming still occupies a central role in the agricultural sector of Tanzania, particularly in the cultivation, processing and export of cash crops including sugar. This study has focused on the technical efficiency of farmers on the sugar plantations. Sugar industry has been chosen as it has the most pronounced outgrowers scheme in the country.

2.2 Sugar production in Tanzania

2.2.1 Estate production

The Tanzania sugar industry consists of five sugar factories and estates, owned by Tanganyika Planting Company Limited (TPC), Kilombero Sugar Company (KSC), Kagera Sugar Limited (KSL) and Mtibwa Sugar Estate (MSE). The KSC operates two estates and factories. Plantation white sugar production started in Tanzania near Arusha

in the early 1930s when the TPC was established (NEI, 1991). A private Danish national operated TPC until the end of the 1970's when it was taken over by the government of Tanzania. From the onset TPC was an irrigated estate in a rather dry area where rain-fed smallholder cane could not be grown. In 1950s the Kagera Sugar Limited factory and estate was established.

Soon after independence, two more plants were established in the Morogoro region, the MSE and KSC. As a result of the increased number of factories, sugar production went up steadily during the 1960s, from approximately 40 000 to 80 000 metric tonnes per annum (NDC, 1992). Production increase during the 1970s and 1980s was less spectacular, and showed significant fluctuations. The average annual output during this period was around 100 000 metric tonnes. In the years since 1985, sugar production has even fallen to levels below 100 000 tons. Production showed a health recovery to between 110 000 and 120 000 metric tonnes in the period 1990-1992. Currently, annual production levels average 135 535 metric tonnes (ESRF, 2002).

The installed capacities of these factories are TPC (64 000 MT), KSC (76 000 MT), MSE (34 000 MT) and KSL (56 000 MT) making a total potential production of 230 000 MT per annum (Sugar Development Cooperation (SUDECO), 2001). Thus the current production is only 71.52% of the potential capacity (Rwambali, 2002). This justifies the need for improving sugarcane production through a number of measures including improvement in technical efficiency.

2.2.2 Outgrower schemes

In the implementation of government agricultural policy, the outgrowers received little attention and support. Both SUDECO and estate managers, including foreign advisors, doubted the potential contribution of outgrowers (NEI, 1991). Their main arguments were the outgrowers' alleged lack of reliability in the supply of cane, their inability to provide the required crop husbandry standards, their reluctance to accept extension advice, their preference for food crops, and their low price responsiveness. The outgrowers' actual role was discouraged by the low ex-farm prices and the inadequate services provided by the estates, which needed all their resources to maintain their own output levels during the 1980s.

The production of outgrowers' cane was limited to Kilombero and Mtibwa. Their share in total output fluctuated from 15-20 percent in 1960s to 25-30 percent in the 1970s, after which it decreased again to some 15 percent during the 1980s. The price increases of the 1990s brought about a sharp rise in the outgrowers' production (Appendix 1) as a result of both acreage expansion and higher yield levels (SUDECO, 2001; NDC, 1992).

2.3 Tanzania's sugar policy

During the past 20 years, the Tanzanian sugar industry has been characterised by a high degree of government intervention in price setting and commodity distribution. For each stage of the marketing chain, the government established prices. Annual fixing of the ex-factory and consumer prices of sugar was a cumbersome procedure, mainly because sugar is a politically sensitive product. Primarily the policy aimed at protecting the consumer from too high prices. In the price setting procedure the factories were the

major players. This resulted in consumer prices below production cost levels, especially during the 1980s. The low ex-factory prices also had an unfavourable effect on outgrowers' production, such as inability to purchase inputs and limited income to pay for normal farm operations such as weeding.

The growing disparity between supply and demand resulting from relatively low consumer prices and stagnating domestic production levels forced the government to introduce a rationing system where target groups and areas were allocated specific quotas. The distribution of sugar was put in the hands of SUDECO.

The structural adjustment programmes introduced in 1986 led to important changes in the sugar industries policy. The main changes were:

- The estates' improved access to foreign exchange, mainly in the form of retention of money from export earnings. In 1986, the sugar industry was allowed to retain its entire export earnings to finance the imports of both inputs and capital equipments;
- The reduction of SUDECO's role and drastic changes in the regulations governing the estates' personnel policy;
- A liberalisation of imports and domestic trade arising from the abolition of SUDECO's monopoly position and a larger role for private traders;
- In April 1992 the government of Tanzania decided to deregulate sugar marketing and to abolish the pan-territorial pricing system;

- Increases in ex-factory prices to facilitate economic operations. As a result of these increases, nominal consumer prices multiplied six fold to TShs 155 in 1990 then to TShs 185 in 1992. Currently the consumer price is around TShs 500 per kg.

The sugar policy changes introduced during the latter half of 1980s have brought about a major improvement in the sugar industry: sugar production has increased substantially, outgrowers have increased their share in total output because of higher prices and factories have improved their capacity utilization.

2.4 The economic and social role of plantations in Tanzania

Plantation agriculture started in the 1890s when coffee and sisal were established around the Usambara Mountains during the colonial era. There has been very little research about plantation agriculture in Tanzania. Politicians and other policy makers are usually silent about the existence of plantations (Mbilinyi, 1998).

Plantation agriculture has a great impact on production, export earnings (about 70% of foreign earning is from agriculture exports) and wage employment. By and large, plantations provided ample wage employment opportunities for people have demonstrated modern farming methods and have enhanced local managerial expertise required in running them (Katunzi, 1990).

2.5 Problems confronting outgrower farmers in Tanzania

Outgrower farmers in Tanzania are faced with a number of constraints, including poor physical, technological and financial infrastructure; inadequate extension services; and inadequate raw materials such as pesticides, fertilizer and herbicides. Lack of anti-dumping legislation and the influence of donors support on the reform process continue to hinder development of the outgrowers.

The outgrowers operate on holdings that many be considered too small to permit economic efficiency. About 86 percent of outgrowers operate on farms that are less than five hectares. It is also estimated that 10 percent of the land that small farmers operate is not owned by them (Mbilinyi and Semakafu, 1995). The many tenure arrangements, i.e. family land, rented land or village land may discourage outgrowers from cultivating sugarcane even though they know there are profits to be gained by doing so.

Labour shortages are also one of the important constraints facing the outgrowers. This is due to the fact that outgrowers are close to the estate hence compete for labour especially during planting, weeding, and harvesting times. As the outgrowers are close to the estate, the price of labour is set by a comparison of the wage offered by the estate, and is quite often higher than the outgrowers can afford (Rawlins, 1989). In order for outgrowers to overcome the labour shortages caused by competition with the plantation itself, outgrowers have had to increase the wage levels they pay workers, and they have cut the weeding frequency to once per season so as to reduce production costs (Mbilinyi

and Semakafu 1995). This labour shortage exerts a negative impact on the timing of the planting and weeding exercises, further reducing productivity.

Lack of adequate capital is another major constraint to outgrowers. Delayed payment of sugar cane sales makes it impossible for the outgrowers to have enough capital during the weeding period, which is very important in sugarcane farming. Most farms are not well cleaned, again leading to low productivity.

In addition to the above mentioned constraints, other constraints that have been cited in previous studies are low sugarcane prices paid to outgrowers, unreliable allotment of MSE services, limited access to land and as a result competition between sugar cane and food crops, limited investment opportunities, and marketing problems (Sprenger, 1991; Senkondo and Ashimogo, 1991; Senkondo, 1988; and ESRF, 2002). The future development of outgrower schemes is threatened by the above-mentioned factors that hinder the sugar production industry especially on the outgrower side.

2.6 The concept of technical efficiency

The concept of technical efficiency is elaborated by Farrell's (1957) efficiency index presented in Figure 1 in which labour and capital have been considered as the major inputs into the production process. A farmer who produces the output level q, using the two inputs L (labour) and K (capital), at point B, is technically inefficient as compared to the frontier farmer, who operates at point A. The technical efficiency of the farmer/firm relative to the efficient frontier or best practice farmer/firm would then be

represented by the ratio OA/OB. Hence the appropriate measure of technical efficiency should be based on the "best practice" or frontier production function and technical inefficiency articulates the failure of the producer to produce on the outer bound of the enterprise's production frontier.

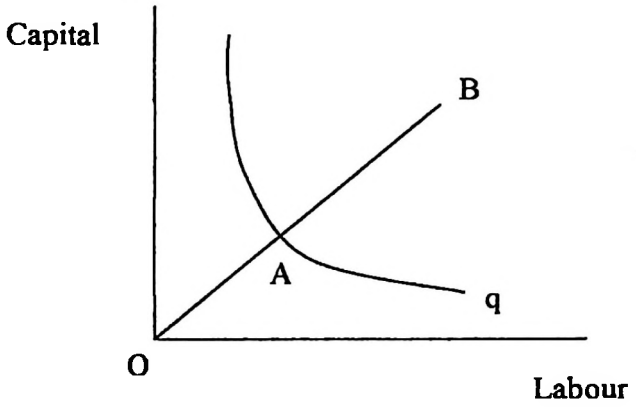

Figure 1. Farrell's Efficiency Index

2.7 Measuring technical efficiency

The estimation of the productive efficiency of a firm in relation to other firms in an industry has been an area of great interest in economics (Admassie and Matambalya, 2002). Measurement of technical efficiency can be grouped into non-parametric and parametric frontiers.

The non-parametric frontier models do not impose functional forms on the production frontier and do not make assumptions about the error term. They use linear programming methods for estimating technical efficiency. For instance, Farrell's (1957) work, which has attempted to measure technical efficiency in a manner consistent with

the definition of production function but without imposing a functional form, can be considered non-parametric. This approach has many limitations (Admassie and Matambalya, 2002; Madan et-al 2000; Rawlins, 1989) such as

- It is extremely sensitive to outliers in the data set;
- It does not take into account non-constant returns to scale;
- It does not take into account the uneconomic areas of the production function where inefficiency index is undefined; and
- It does not lend itself up to standard statistical tests of significance.

The parametric frontier (used in this study) on the other hand, imposes a specific functional form as a mathematical representation of the production frontier; the most commonly used functional forms being the Cobb-Douglas and the translog production functions.

The measurement of a firms technical efficiency level can be deterministic, where all deviations from the frontier are attributed to inefficiency, or stochastic, which is a considerable improvement, since it is possible to discriminate between random errors and differences in inefficiency (Admassie and Matambalya, 2002; Piesse and Colin, 2000).

Deterministic parametric frontiers are relatively simple to estimate but are also subject to several limitations. The most important limitation relates to the fact that any deviation from the frontier is considered to be due to technical inefficiency. Thus deviations from

the frontier due to influences such as bad luck, bad weather, statistical noise and measurement errors are all blamed on actual technical inefficiency.

Unlike the deterministic frontier models, stochastic frontier models assume that firms may deviate from the frontier not only because of technical inefficiency but also because of measurement errors, statistical noise or any non-systematic influence. The frontier production function with a composed error term, which was developed independently by Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977) is, nowadays one of the most used technical efficiency measures. Although today the model has been improved to account for panel data, the model was originally developed to handle cross-sectional data.

2.8 The stochastic frontier model with technical efficiency effect

The stochastic frontier production function has two error terms one to account for random effects (e.g., measurement errors in the output variable, weather conditions, diseases, etc. and the combined effects of unobserved/uncontrollable inputs on production) and another to account for technical inefficiency in production.

The stochastic frontier production function can be written as

$$Y_i = f(X_i; \beta) \exp(V_i - U_i). \qquad (1)$$

Where Y_i is the production of the i^{th} farm, X_i is a vector of inputs used by the i^{th} farm; β is a vector of unknown parameters, V_i is a random variable which is assumed to be independently and identically distributed (iid) $N(0,\sigma_V^2)$ and independent of U_i and U_i is

a random variable that is assumed to account for technical inefficiency in production. Following Battese and Coelli (1995), U_i is assumed to be independently distributed as truncation (at zero) of the normal distribution with mean, μ_i and variance, σ_U^2 ($|N(\mu_i, \sigma_U^2)|$)[1], where

$$\mu_i = Z_i \delta \qquad (2)$$

Where, Z_i is a 1* c vector of farm-specific variables that may cause inefficiency and δ is a c * 1 vector of parameters to be estimated. The farm-specific stochastic production frontier representing the maximum possible output (Y^*) can be expressed as

$$Y_i^* = f(X_i;\beta) \exp(V_i). \qquad (3)$$

Equation (1) may be rewritten using equation (3) as

$$Y_i = Y_i^* \exp(-U_i). \qquad (4)$$

Thus, technical efficiency of the I^{th} farm, denoted by TE_i, is given by

$$TE_i = Y_i / Y_i^* = \exp(-U_i). \qquad (5)$$

This means the difference between Y and Y^* is embedded in the U_i. If $U_i = 0$, then Y is equal to Y^*. This means production lies on the stochastic frontier and hence technically efficient and the farm obtains its maximum possible output given the level of inputs. If $U_i > 0$, production lies below the frontier and the farm/firm is technically inefficient (Dey *et-al.*, 2000).

Given the importance of plantations in Tanzania and the problems facing the sugar industry especially that of low productivity and limited land, the estimation of technical

[1] The original specification of U to be half-normal ($N(0,\sigma_U^2)$) (Aigner et al. 1977) has been applied over the past decades (Coelli, 1994). If it will not follow a half-normal distribution it will follow either exponential or truncated normal at zero. The study of Parikh et al. (1995); Greene, (1990) and Kirkley et al. (1995) concluded that efficiency levels were essentially the same for half-normal, truncated-normal and exponential distribution.

efficiency is of immense importance. With many available ways of estimating technical efficiency this study uses the Cobb-Douglas stochastic frontier production model so as to avoid the more serious limitations of other estimation techniques such as the non-parametric frontier measures and deterministic production frontier models where all deviations from the frontier are attributed to inefficiency.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area

Turiani division was selected for the study due to two major reasons. First, there is a large number of outgrower farmers in the area. Second it's close proximity to Morogoro town and Sokoine University of Agriculture (SUA), made it easier for the researcher to access literature and facilities. Turiani division is found in Mvomero District about 100 kilometers from Morogoro town along the Kilosa – Handeni road. The district lies between longitudes 37^0 10' to 38^0 31' East of Greenwich and between latitudes 5^0 5' to 7^0 4' South of the Equator. Turiani is found at Longitude 37^0 36' East and Latitude 6^0 00' South. The division is comprised of five wards namely, Mtibwa, Sungaji, Mhonda, Diongoya and Kanga. The division headquarter is in Sungaji ward.

Climate and Topography

The altitude of Turiani division is between 380 meters and 520 meters above sea level. This altitude provides a suitable climate for tropical and subtropical varieties of crops. The division receives a bimodal type of rainfall with peaks in April and December while May to October remains relatively dry. The average rainfall amounts to 1200mm per annum with variations from 800mm to 2000mm. The mean annual precipitation is marginal for cane growing under rain-fed conditions, taking account of the annual distribution pattern and year-to-year variation.

The prolonged dry season, which is beneficial for harvest operations, unfavorably affects yield level. Average monthly rainfall is about 106mm making up a total annual rainfall of about 1270mm.

Population.

According to the population census of 2002 (United Republic of Tanzania, 2003), Mvomero District had a population of about 260 525 people with a population growth rate of 2.6%. Turiani had a total population of about 90 129 with an average of 4.6 people per household and an average population density of 22.3 persons per square km.

Agriculture

The main crops grown are cassava, rice, maize, and bananas. Other crops include beans, millet, peas, potatoes, coffee, groundnuts, citrus fruits, mangoes, jackfruits, sugarcane, coconut, tomato and eggplant. With exception of paddy and sugarcane fields, cultivation is carried out mainly by use of the hand hoe, using primarily family labour and hired labour when the situation demands. Tractors are available only from a few individuals. Very few farmers in the division keep livestock.

3.2 Study design

The design of this study involved a cross sectional single visit survey. This design allowed collection of data at one point in time i.e. during September and October 2002.

3.3 Sampling procedure

3.3.1 Study population

The study population included a representative sample of outgrower farmers and a cohort representative sample of non-outgrower farmers residing in the area surrounding the MSE.

3.3.2 Sample size

Random sampling was used to obtain both outgrower and non-outgrowers farmers. The total sample size of the study was 140, with 69 outgrower farmers (3% of all outgrowers) and 71 non-outgrower farmers. Most of the sampled non-outgrowers were mainly rice farmers. Although the sample size was limited to 140 (due to time and budget constraints), it was large enough to allow for statistical analysis.

3.4 Data collection

Data for this study were collected through informal and formal surveys. Informal surveys were carried out to get an in depth understanding of issues related to the sugar cane industry and the outgrower schemes. The formal survey involved personal interviews using a pre-tested questionnaire (Appendix 2). The information collected included socio-economic data, farming inputs and practices as well as outputs and productivity.

The researcher and one trained enumerator conducted the interviews. To ensure a higher rate of response for the interview, the team conducted interviews with the respondents at their homesteads.

Secondary data such as the out-growers' contribution to total sugar production, and other relevant secondary information were extracted from reports and other documentary materials from the relevant bodies/institutions such as MSE, Mtibwa Out grower Association (MOA), and Sokoine National Agricultural Library (SNAL).

3.5 Model specification

Since stochastic frontier production models were proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977), there has been a vast range of their applications in literature. For detailed literature surveys see Greene (1993) and Coelli, Rao and Battese (1998). The model was originally defined for the analysis of cross-sectional data but various models to account for panel data have been introduced by Pitt and Lee (1981), Cornwell, Schmidt and Sickless (1990), Kumbhakar (1990), and Kumbhakar, Ghosh and McGuckin (1991).

Battese and Coelli (1995) proposed a stochastic frontier production function, which has firm effects assumed to be distributed as a truncated normal random variable, in which the inefficiency effects are directly influenced by a number of variables.

To estimate technical efficiency the study utilizes the stochastic frontier production model proposed by Battese and Coelli (1995). Given our research objectives, the generalized stochastic frontier model can be expressed for two groups of farmers as:

$$\text{Ln } Y_{io} = \beta_{0o} + \beta_{1o} \ln L_{io} + \beta_{2o} \ln Fl_{io} + \beta_{3o} \ln Hl_{io} + \beta_{4o} \ln R_{io} + \beta_{5o} \ln C_{io} + \epsilon_I \quad (6)$$

and

$$\text{Ln} Y_{in} = \beta_{0n} + \beta_{1n} \ln L_{in} + \beta_{2n} \ln Fl_{in} + \beta_{3n} \ln Hl_{in} + \beta_{4n} \ln R_{in} + \beta_{5n} \ln C_{in} + \epsilon_I \quad (7)$$

Ln = denotes logarithms to base e

Y = the maximum attainable output for a given level of all inputs, measured in kg.

L = Land area cultivated, measured in hectares.

Fl = Family labour utilized, measured in man-days.

Hl = Hired labour utilized, measured in man-days.

R = Total variable inputs (seeds, fertilizer, pesticides, harvesting bags) used and measured in Tanzanian shillings.

C = the value of total capital equipment (hand hoe, machete, bicycle, axe, forked hoe, and sickle) measured in Tanzanian shillings.

β_i's = are unknown parameters to be estimated.

According to Aigner, Chu and Lovell (1977), the error term is really a composite of two terms:

$$\epsilon_i = V_i - U_i ; \qquad i = 1,\ldots,N \quad (8)$$

where

V_i = represents independently and identically distributed random errors N $(0,\sigma_v^2)$. These are factors outside the control of the firm.

U_i = represents non-negative random variables which are independently and identically distributed as N $(0, \sigma_u^2)$ i.e. the distribution of U_i is half normal. $|U_i| > 0$ reflects the technical efficiency relative to the frontier production function. $|U_i| = 0$ for a firm whose production lies on the frontier and $|U_i| > 0$ for a firm whose production lies below the frontier.

Knowing that firms are technically inefficient might not be useful unless the sources of the inefficiency are identified (Admassie and Matambalya, 2002). Thus, the second stage of this analysis investigates the sources of the firm-level technical inefficiency for the sampled outgrower and non-outgrower farmers.

The model specification for outgrower farmers was,

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + W_i \qquad (9)$$

Where

Z_1 = age of the farmer in years

Z_2 = level of education of the farmer in years

Z_3 = Mtibwa ward dummy (1 for Mtibwa and 0 otherwise)

Z_4 = Diongoya ward dummy (1 for Diongoya and 0 other wise)

Z_5 = Kanga ward dummy (1 for Kanga and 0 otherwise)

Z_6 = originality of the farmer (1 for farmer from Mtibwa division and 0 for migrants)

Z_7 = number of years the farmer has been an outgrower (apply only for outgrower farmers)

Z_8 = total farm area measured in hectares

W_i = an error term that follows a truncated normal distribution

δ_I's = inefficiency parameters to be estimated

With exception of Z_7, the inefficiency model and variables for non-outgrower farmer are the same as the outgrower farmer technical inefficiency model.

3.6 Data analysis

Responses from the interview were coded, summarized, and entered in a computer. Analysis was done using the computer program for stochastic frontier production and cost function estimation (FRONTIER Version 4.1) by Coelli (1996). Descriptive statistics such as frequency distribution and cross tabulation were also used. The technical efficiency of the outgrower and non-outgrower farmers were estimated using the Cobb-Douglas production frontier using the cross–sectional data assuming a truncated normal distribution as specified in the previous sections. After estimation of the technical efficiency, the causes of technical inefficiency are estimated using the Battese and Coelli (1995) specification, also described above.

3.7 Limitations of the data

a) Use of cross sectional data limits observation over time. This makes it difficult for the study to account for changes due to time difference.

b) The small sample size may affect the representative ness of the population parameters. However the sample was large enough to allow for statistical analysis.

c) A case study approach as used by this study limits observation to only one scheme. Hence the conclusions reached may not hold for other similar schemes.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Overview

This chapter presents the results and discussion of the study. The results are divided into two main sections; the first section explains the sample characteristics and the second section addresses the empirical results from the stochastic frontier model.

4.2 Sample and respondents' profile

4.2.1 Sample profile

The study covered three wards namely Diongoya, Kanga and Mtibwa. A total of 140 farmers were sampled and considered to represent the rest of the farmers in Mtibwa division. About 57.0 percent of the farmers were from Diongoya while Kanga and Mtibwa had 10.7 and 32.1 percent respectively (Table 1). The small number of respondents from Kanga ward was due to the fact that the ward is far from the Mtibwa factory and thus it has few sugar cane farmers.

Of the 140 respondents 62.9 percent were males and the remaining 37.1 percent were females. The smaller percentage of female respondents can be explained by the fact that in Turiani and Tanzania in general men still control most resources of the family.

Table 1: Ward and gender of farmer (n = 140)

Ward	Sex of the respondent (%)		
	Female	Male	Total
Diongoya	20.0	37.1	57.1
Kanga	2.9	7.9	10.8
Mtibwa	14.2	17.9	32.1
Total	37.1	62.9	100.0

It was observed that Kanga ward has 2.9 percent of all out growers. This can be explained by high transportation costs as the ward is far from the factory. Diongoya ward, which is surrounding the Mtibwa factory, has a higher percentage of outgrowers compared to the two remaining wards. Mtibwa ward, which is the closest to the factory, was expected to have more out growers but this was not the case. This is due to the fact that Mtibwa ward is the centre of Turiani Division hence people in it depend more on other commercial activities than farming. Also as the factory is in the ward, most of the farms in it belong to MSE thus forcing people to move to Diongoya ward for sugarcane production.

4.2.2 Respondents' profile

4.2.2.1 Age

The range of age of the respondents was from 20 years to a maximum of 73 years. About 44.3 percent of the respondents were between the age of 20 and 35 years, 39.3% between 36 – 50 years and 16.4% were over 50 years (Table 2). The age of the farmer is

one of the factors that can explain the level of technical efficiency as used by Basnayake and Gunaratne (2002). Age affects experience, wealth and decision-making, all of which affect how the individual works. Thus age can influence the productivity of an individual.

Table 2: Age of respondents

	Frequency	Percent
Between 20 and 35 years	62	44.3
Between 36 and 50 years	55	39.3
50 years and above	23	16.4
Total	140	100.0

4.2.2.2 Marital status

About 81.4 percent of the respondents were married. This shows that the society is stable; the divorce rate was low at only 2.1 percent. A Stable family can concentrate more on production than an unstable one and thus may influence efficiency in production. It can be seen in Table 3 that 10.7 percent of the respondents were single.

Table 3: Marital status of respondents

	Frequency	Percent
Married	114	81.4
Single	15	10.7
Widowed	8	5.7
Divorced	3	2.1
Total	140	100.0

4.2.2.3 Origin of the farmer

The question about the origin of the respondent was aimed at examining the migration rate into the division. It was observed that about 37 percent of the respondents are migrants into the division.

A reliable market and higher returns from sugarcane production can be a cause of this migration to the area. About 42 percent of all migrants are outgrowers. Easy availability of land can be another reason for this pattern of migration. Appendix 3 shows that 59.2 percent of all migrants are from Kilimanjaro region, which is known to have reached a land saturation point two decades ago. Also this could be due to the entrepreneurial tendencies of the Chagga, which make them aggressive in search for opportunities to prosper.

4.2.2.4 Employment status

The employment status of an individual affects his/her income and thus directly or indirectly his/her productivity. About 88 percent of the respondents were farmers. The remaining were either self-employed (5.7%), government employees (2.9%), or employed in the private sector (especially by MSE) 3.6 percent (Table 4).

Table 4: Employment status

	Frequency	Percent
Self employed	8	5.7
Government employee	4	2.9
Private sector employee	5	3.6
Farmer	123	87.9
Total	140	100.0

Most of the government and private sector employees were also outgrowers. It was observed that about 50 and 60 percent of government and private sector employees respectively are outgrowers.

4.2.3 Land acquisition

The land tenure agreements such as rent in any of it's many forms, family land or joint ownership may discourage farmers from cultivating semi permanent crops even when it can be shown that there is a comparative advantage in doing so (Rawlins, 1989). It can be seen in Table 5 that land under cultivation can be acquired through leasing, inheriting

(family land), buying, or can be given by the village. About 51 percent of the land in Turiani division is family land, meaning it has been inherited. Twenty one percent of the land was bought while 8.9%, 11% and 7.5 percent of land has been acquired through lease, from within the village or from other means, respectively.

Table 5: Land acquisitions

	Count	Percentage
Leased	13	8.97
Inherited	74	51.03
Bought	31	21.38
From village	16	11.03
Others	11	7.59
Total	145	100.00

It can be seen in Appendix 4 that of all farmers who acquired land by leasing, are not cultivating sugarcane. This agrees with what Rawlins (1989), pointed out that farmers under lease contract farmers are not likely to cultivate permanent crops.

4.2.4 Ownership of implements

Implement ownership has influence on the productivity of the farmer. Appendix 5 shows the percent of respondents owning various implements. About 98 percent of all respondents own hand hoes. This indicates that most of the farming operations are done by primitive tools thus requiring high manpower. In addition to hand hoes, most non-outgrowers of sugar, the majority of whom are paddy growers, own sickles, which are

mostly used for harvesting of rice. This shows the relationship between implement ownership and production and productivity of a farmer. Hence, capital equipment is used as one of the factors that influence output.

4.2.5 Major sources of income

Major sources of income (as presented in Table 6 and Appendix 6) were sought to shed light on the aspect of sources of income and its relationship to the employment status of the farmer. From Table 6 it can be seen that 90.7 percent of the respondents' major source of income is from farming. The remaining percentage is accounted for by respondents whose major source of income is from farming and salary (3.6%), farming and livestock (2.9%), and from farming and other sources (2.9%).

Table 6: Major sources of income

	Frequency	Percent
Farming	127	90.7
Farming and salary	5	3.6
Farming and livestock	4	2.9
Farming and other	4	2.9
Total	140	100.0

4.2.6 Marketing of produce

The marketing of produce has a direct relationship to the farmer's income. Timely marketing and finding the right buyer who pays at the right time is important in the whole circle of farming. Late payment for sold produce makes it difficult for farmers to meet their commitments (weeding, spraying and fertilizer application) in time hence affecting the following season's production and income. The different marketing strategies revealed some of the problems facing the farmers in Turiani Division.

4.2.6.1 Time of selling produce

Due to the nature of sugarcane, outgrowers have to sell their produce soon after harvesting. In most cases the harvesting is done by MSE hence often times the produce reaches the factory on the same day. Non-outgrowers (rice farmers) have to make decisions about selling or not selling according to the circumstances surrounding them. Table 7 shows the responses of rice farmers on the question related to "when they sell their produce". It can be observed that 64.4 percent of non-outgrowers store their produce for sale at later times when prices are better.

In Turiani division soon after harvesting (May, June and early July) the price of rice is around 5 000/= TShs. per 100kg bag. But towards the beginning of a new season the price reaches around 13 000/=TShs per 100kg bag. However immediate cash needs and high costs of storage forces some farmers to sell their produce soon after harvesting. It can also be seen in Table 7 that some farmers sell part of their produce soon after harvesting and the other part is stored for later sale.

Table 7: Time of selling most produce

	Frequency	Percent
Soon after harvesting	17	23.9
Store and sale later	45	63.4
Soon and store for later sale	9	12.7
Total	71	100.0

4.2.6.2 Payment conditions

One of the problems facing the outgrowers is condition of payment in sale of produce. It can was observed that only 52.5 percent of the farmers are paid immediately after selling produce while the remaining 47.5 percent are paid later. However, all payments are paid in cash.

It can be observed that 98.6 percent of those who are being paid immediately are non-outgrowers, and that 95.6 percent of outgrowers are being paid later. This explains the large number of outgrowers who complain about being paid on time for their produce. Some outgrowers pointed out that it might take up to two months for them to be paid. This affects the ability of the outgrowers to look after their farms especially during weeding time, which has to be done soon after sugarcane has been harvested.

4.3 The Empirical results

The summary statistics related to variables used for analysis for both outgrowers and non-outgrowers are depicted in Table 8. The means of inputs presented in Table 8, suggest that at the time of the survey, non-outgrower farmers lagged on both counts.

Table 8: Summary statistics for variables in the stochastic frontier production function for outgrowers and non-outgrowers

	Outgrowers				Non-outgrowers			
	Min.	Max.	Mean	Std. Deviation	Min.	Max.	Mean	Std. Deviation
Output (ton)	5.00	600.00	89.10	109.55	.20	65.00	3.08	7.81
Farm area (Ha)	1.00	20.00	3.57	4.10	.50	50.00	2.86	6.03
Family labour (Man days)	.00	5400.00	801.58	1326.79	.00	5716.00	693.11	927.56
Hired labour (Man days)	280.00	12,800.00	1491.72	1982.98	.00	2796.00	476.18	627.33
Variable inputs (TShs.)	1200.00	558,200.00	86,694.12	128,933.31	.00	550,000.00	26,505.63	66,304.89
Equipments (TShs.)	500.00	349,000.00	59,681.88	56,028.82	.00	385,000.00	51,698.59	60,534.59

4.3.1 Production frontier and technical efficiency estimates of outgrower and non-outgrower farmers

The OLS as well as maximum likelihood (ML) estimates of the Cobb-Douglas model are presented in Table 9 and Table 10 respectively. Separate estimates are shown for the

outgrowers and non-outgrowers. It can be seen in Table 9 that the OLS estimates results have the expected sign and some are significant, especially for the outgrowers. Farm area, which represents the area under cultivation, is highly significant for both groups.

Table 9: OLS estimates for parameters of the Cobb-Douglas production function for outgrowers and non-outgrowers

		Outgrowers			Non-outgrowers		
Variable	Parameter	Coefficient	S. E.	t ratio	Coefficient	S. E.	t ratio
Constant	B_0	3.9666	1.2447	3.187***	-0.5133	0.5136	-0.999
Farm area	B_1	1.2321	0.2000	6.161***	0.9204	0.1011	9.098***
Family labour	B_2	0.0019	0.0258	0.075	-0.0058	0.0335	-0.174
Hired labour	B_3	-0.2774	0.1882	-1.474	0.0269	0.0228	1.182
Variable inputs	B_4	0.0618	0.0153	4.034***	0.0445	0.0495	0.899
Equipments	B_5	0.0259	0.0391	0.664	-0.0027	0.0317	-0.085

Note: Significance levels of 1%, 5%, and 10% are indicated by ***, **, and * respectively.

The estimate of γ is 0.62 and 0.87 for outgrowers and non-outgrowers respectively. This indicates that for both groups of farmers, by far the largest portion of error variation is due to the inefficiency error u_i (and not due to the random error v_i) implying that the random component of the inefficiency effects does make a significant contribution in the analysis. The one sided LR test of $\gamma = 0$ provide a statistic of 21.2679 and 20.3892 for outgrowers and non-outgrowers respectively which both exceed the chi-square five

percent critical value. Hence the stochastic frontier model appears to give a significant improvement over the average (OLS) production function.

Table 10: Maximum likelihood estimates for the parameters of the Cobb-Douglas stochastic frontier production function

		Outgrowers			Non-outgrowers		
Variable	Parameter	Coefficient	S. E.	t ratio	Coefficient	S. E.	t ratio
Constant	B_0	4.5384	0.9659	4.698***	-0.0152	0.3922	-0.038
Farm area	B_1	1.0157	0.1691	6.003***	0.9545	0.0901	10.587***
Family labour	B_2	-0.0229	0.0216	-1.061	-0.0288	0.0290	-0.991
Hired labour	B_3	-0.2614	0.1412	-1.851*	0.0127	0.0189	0.675
Variable inputs	B_4	0.0581	0.0131	4.456***	0.0479	0.0176	2.721**
Equipments	B_5	0.0217	0.0314	0.692	-0.0143	0.0249	-0.578
σ^2		0.3370	0.1663	2.026**	0.7988	0.3492	2.287**
γ		0.6221	0.2419	2.571**	0.8763	0.0414	21.158***
Log likelihood		-38.8130			-32.3790		
LR test		21.2679			20.3892		

Note: Significance levels of 1%, 5%, and 10% are indicated by ***, **, and * respectively.

The estimated ML coefficient of the extent of land under cultivation showed positive values of 1.0157 and 0.9545 for outgrowers and non-outgrowers respectively, which were significant. Therefore, an increment of land (farm area) under cultivation by one percent will increase output of outgrowers and non-outgrowers by 1.0157 and 0.9545 percent respectively. Basnayake and Gunaratne, (2002); and Rawlins, (1989) reported similar results.

The estimated coefficients for family labour, and hired labour showed negative values of 0.0229 and 0.2614 respectively for outgrowers. The hired labour coefficient value was significant. This indicates that an increment of one percent of family labour and hired labour will reduce output by 0.0229 and 0.2614 percent respectively. This indicates that outgrowers currently over use family labour and hired labour. For non-outgrowers the estimated coefficient for family labour was a negative value of 0.0288, indicating excess use of family labour. This can be due to the fact that nearly a whole month is devoted for scaring birds in rice paddy farms. Due to high labour costs bird scaring is often done by family members. The estimated coefficient value for hired labour is positive (0.0127). However, it is not significant hence no conclusive statement can be made regarding the effect of hired labour on non-outgrowers output.

The estimated ML coefficients for variable inputs showed positive values of 0.0581 and 0.0179 for outgrowers and non-outgrowers respectively, which are highly significant. This indicates that an increment of the variable inputs for both outgrowers and non-outgrowers by one percent will increase output by 0.0581 and 0.0179 percent respectively. As the increase in output is small this may indicate that variable inputs are nearly fully utilized.

The estimated ML coefficient of capital equipment used showed a positive value of 0.0217, which was not significant for outgrowers. Thus, an increment on capital equipment by one percent will increase output by 0.0217 percent. However, contrary to expectations, the coefficient of capital equipment for non-outgrowers showed a negative

value of 0.0143. This indicates that an increment in capital equipment will decrease the non-outgrowers output.

4.3.2 Sources of technical inefficiency of outgrower and non-outgrower farmers

The mean technical efficiency of outgrower farmers was found to be 76.43 percent, which indicates that the output could be increased (using existing resources and technology) by 23.57 percent if all outgrowers achieved the efficiency level of the best outgrower. The mean technical efficiency for non-outgrowers was found to be 80.65 percent. This indicates that output of non-outgrowers could be increased by 19.35 percent if all non-outgrowers achieved the efficiency level of the best non-outgrower. Table 11 shows the distribution of technical efficiencies of outgrowers and non-outgrowers in Turiani division. The results also indicate that the technical efficiency for outgrowers and non-outgrowers ranges from 21.91 to 94.32 percent and from 12.94 to 94.71 percent respectively. It can also be observed that most of the farmers (81.43%) are efficient because they have technical efficiency levels of above 70%. A t-test was done to see if there was any significant difference between the technical efficiency of outgrowers and non-outgrowers. The results show that there is no significant difference between the technical efficiency of outgrowers and non-outgrowers at the 0.05 significance level. On the basis of these results we fail to reject the hypothesis that there is no significant difference between outgrowers and non-outgrowers. This could be due to the similar socio-economic situations facing both farmers in the division. It could also be due to the fact that some of the sugarcane outgrowers also have rice farms and thus resources available are used for both crops.

The estimated coefficients in the inefficiency models are of particular interest to this study and are depicted in Table 12. A wide variation of technical efficiencies among the outgrowers and non-outgrowers justifies the need for analysing the causes of technical inefficiencies.

Farmer's individual characteristics such as age, education level, experience measured in years and size of the farms was included in the inefficiency models for outgrowers and non-outgrowers. Ward dummies to control ward differences were also included. In addition a dummy variable for the origin of the farmer was also included in the analysis.

It should be noted that since the explained variable in the inefficiency function is the mode of inefficiency, a positive sign on a parameter in Table 12 indicates that the associated variable has a negative effect on efficiency and a negative sign indicates a positive efficiency effect.

Table 11: Distribution of technical efficiencies based on Cobb-Douglas specification

Technical efficiency %	Outgrowers	Non-outgrowers
	Number of farmers	Number of farmers
10 – 20	0	1
20 – 30	4	0
30 – 40	0	0
40 – 50	2	0
50 – 60	3	7
60 – 70	7	2
70 – 80	10	13
80 – 90	32	36
90 – 100	11	12
Total	69	71

The age coefficients appeared to be positive and significant for outgrowers and negative for non-outgrowers. This indicates that older outgrowers were less efficient than younger ones. This could be due to the fact that sugarcane cultivation is very strenuous giving the younger farmers an advantage. On the other hand rice cultivation may require a more sophisticated physical skill giving the older farmers an advantage.

It could also be due to the fact that most of the younger outgrowers farms are new and more fertile hence have the potential for higher yields. But the case is different for non-outgrowers where older farmers were found to be more efficient than younger ones. This agrees with the literature, which showed age to have a negative relationship with

inefficiency (and positive with efficiency) (Admassie and Matambalya, 2002; Dey, *et al.*, 2000; and Jaume, 2000).

Table 12: Determinants of technical inefficiency

		Outgrowers			Non-outgrowers		
Variable	Parameter	Coefficient	S. E.	t ratio	Coefficient	S. E.	t ratio
Constant	δ_0	0.3723	0.8355	0.445	3.1647	1.9209	1.647*
Age	δ_1	0.0274	0.0159	1.723*	-0.1310	0.0893	-1.465
Education	δ_2	-0.1281	0.0500	-2.561**	-0.1683	0.1456	-1.155
Mtibwa	δ_3	0.3871	0.6595	0.586	0.9467	0.7875	1.202
Diongoya	δ_4	-0.0362	0.6844	-0.052	0.8695	0.7543	1.152
Kanga	δ_5	0.0214	0.9935	0.021	1.3484	1.0255	1.314
Origin of the farmer	δ_6	-0.6437	0.4011	-1.604*	-1.6413	1.1371	-1.443
Experience	δ_7	-0.0665	0.0487	-1.365	-0.1206	0.1102	-1.093
Farm area	δ_8	-0.1667	0.0763	-2.184**	0.0280	0.0462	0.607

Note: Significance levels of 1%, 5%, and 10% are indicated by ***, **, and * respectively.

Coefficients of education showed negative values for both outgrowers and non-outgrowers. The negative significant coefficient value for education suggested that more educated farmers are more efficient than the less educated. This result is consistent with the idea that schooling increases information and consequently leads to higher production efficiency (Seyoum, Battese and Fleming, 1998). Similar results have also been reported by Basnayake and Gunaratne (2002); and Dey, *et al.* (2000).

The results also show that inefficiency decreases with the experience of the farmer. Pagán (2001) reported similar results. A dummy variable for Mtibwa had a positive sign for both outgrowers and non-outgrowers. This indicated that efficiency levels are greater outside Mtibwa ward. This could be due to the fact that as noted earlier Mtibwa ward is of a more commercial nature than agricultural, as the ward has grown into a small town.

The negative coefficient for origin of the farmer for both outgrowers and non-outgrowers indicated that migrants to the division appeared less efficient. This could be due to limited access to resources such as land. The coefficient for farm area had a negative value and was significant for outgrowers. This suggests that farmers with larger land area are relatively more efficient.

4.4 Chapter Summary

Results have showed that there was no significant difference between the technical efficiency of outgrowers and non-outgrowers at 0.05 significance level. This made the study fail to reject the null hypothesis that there is no significant difference in technical efficiency between outgrower and non-outgrower farmers. Also the results showed that socio-economic and demographic variables such as age, education level, origin of the farmer, farm area and experience have significant influence on level of technical efficiency for both outgrower and non-outgrower farmers. This made the study reject the null hypothesis that socio-economic and demographic variables have no significant influence on level of technical efficiency for both outgrower and non-outgrower farmers.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The primary objective of the study was to estimate the technical efficiency and determinants of inefficiency of sugarcane farmers in Turiani Division. According to the results obtained from the stochastic frontier estimation, the average technical efficiency of outgrowers and non-outgrowers given by the Cobb-Douglas model is 76.43 percent and 80.65 percent respectively. This indicates that there is a scope of further increasing the output of outgrowers and non-outgrowers by 23.57 percent and 19.35 percent respectively without increasing the levels of inputs.

Several factors affect technical efficiency. For outgrowers these include; age, origin of the farmer, educational level, and farm area. All these were significant at the 10% and 5% levels of significance. For the non-outgrowers none of these were significantly related though all had expected signs. According to the results, older farmers are more efficient for non-outgrowers than younger farmers. This could be due to good managerial skills, which they have learnt over time. Therefore, younger farmers should be encouraged to work with older farmers.

Better educated farmers were found to be more efficient than the less educated. This may be because their knowledge, gained from education, has provided them with a background to take correct decisions. For example it would be easier for them to grasp information provided to them by the extension officers. Therefore, it is necessary to increase educational facilities in the area.

Experience showed a positive relationship with efficiency. This may be due to lessons learnt over the years. Therefore farmers with little experience should be encouraged to work with the experienced ones. Farmers from Mtibwa and Kanga wards were found to be relatively less efficient. This could be because of distance for Kanga farmers and the smallholdings in Mtibwa ward. The farmers in Kanga should be encouraged to join efforts so as to reduce the costs of transportation. Farmers residing in Mtibwa should find more farming areas outside the ward especially in Diongoya ward.

Migrant farmers were also found to be relatively less efficient. This could be due to farm area problems as it is not easy for newcomers to secure land easily because it is expensive. Migrants should be encouraged to seek land in areas, where they could acquire larger traits of land and increase their efficiency.

Age and experience are generally related. However, they are not necessarily the same. Therefore more importance should be given to experience, or the length of the farming career ("farming age"). Possibilities of some kind of apprentice system to pair the more experienced farmers with the less experienced, should be explored. Some kind of

incentive might be devised to reward younger farmers to serve a period of apprenticeship, for example making more land available only after such a period.

The possibility of cooperative transport among outgrowers, especially those located further from the factory, would reduce their dependency on the estates. In the future outgrowers may even own cooperative processing plants, further reducing their dependency on the long established estates. Some might argue that this would further liberalize the market and lead to more competition, improving efficiency and lowering costs.

5.2 Recommendations for further research

The results of this study indicate that there are still a number of areas on which further research could be directed to. These include the following:

(a) The efficiency of different forms of relevant information delivery should be explored.

(b) The production efficiency of outgrowers should be compared to the efficiency of the estates.

(c) Similar studies should be conducted in other areas of sugarcane production to compare these results.

(d) The efficiency of processing in the factories should be explored.

(e) The relationship between cane production and processing efficiency should be examined.

(f) The model used in this study should be used to study other crops.

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APPENDICES

Appendix 1: Performance of outgrowers

Year	Production by KSC + MSE	Production by outgrowers	Total production	Outgrowers' % share of total production
1991/92	661 881	174 328	836 209	20.85
1992/93	612 885	272 701	885 586	30.79
1993/94	650 275	483 738	1 134 013	42.66
1994/95	587 026	403 074	990 100	40.71
1995/96	531 707	370 483	902 190	41.06
1996/97	447 760	347 025	794 785	43.66
1997/98	472 604	175 778	648 382	27.11
1998/99	437 753	342 670	780 423	43.90
1999/00	568 792	281 885	885 677	31.83
2000/01	639 441	245 274	884 715	27.72

Source: SUDECO (2002)

Appendix 2: Farmer Questionnaire

Ward.....Village.....Date.....

HOUSEHOLD IDENTIFICATION DATA

1. Name of the Respondent.....
2. Sex of the respondent.....
3. Age of the Respondent.....
4. What is your marital status?
   a) Married ( )
   b) Single ( )
   c) Widowed ( )
   d) Divorced ( )
   e) Separated ( )
5. Are you originally from here?
   a) Yes ( )
   b) No ( )

   If not state the region of origin.....

6. What is your Level of Education?
   a) No formal education ( )
   b) Primary Education ( )
   c) Secondary Education ( )
   d) College and Above ( )

7. Are you an outgrower?

   a) Yes ( )

   b) No ( )

If no give reasons why not

If yes how did you set into outgrower scheme?

8. In which year did you join the outgrower scheme?.....

9. What is your Employment status?

   a) Self-employed ( )

   b) Government Employed ( )

   c) Private Employed ( )

   d) Farmer ( )

10. Household size.....

11. On average how much do you earn per Month from sugar cane production?

.....

PATTERN OF RESOURCE USE

B1. Labour

12. Labour cost in sugarcane production; Area of farm .....ha

Activity	Family labour (man days)	Exchange labour (man days)	Hired labour		
			Man days	Wage rate	
				In kind	Cash
Land preparation					
Seedcane preparation and transport					
Manual planting					
Weeding					
Fertilizer/manure application					
Harvesting					
Loading and transportation					
Others					
Total					

Man-days = No. of laborers * hrs/day * No. days worked

Values of in kind payment are estimates

B2. Land resources

13. How did you get the initial land?

Source	**Area (acre)**	**Cost**
Leased		
From estate		
Inherited		
Bought		
From village		
Others		

If inherited how much money can the land cost at present?.....

B3. Capital Resources

14. What was the initial capital for the business?.....TShs.

15. Machinery and implements owned.

Machinery/ Implement	**No. Owned**	**Initial Cost per unit owned**	**Current value per unit owned**	**Life span (Years)**
Tractor				
Ox-plough				
Hand hoe				
Machete				
Sickle				
Bicycle				
Sprayer				
Axe				
Forked hoe				
Others				

B4. Variable inputs

16. Variable inputs costs

Input	**Seedcane**	**Fertilizer**	**Pesticides**	**Fuel**	**Bags**	**Others**			
Kg.									
TShs.									

OUTPUT

17. What are the major source of income

Farming	( )..... TShs/year.
Salary	( ) ..... TShs/month.
Livestock	( ) ..... TShs/month.
Others	( ) mention.....

18. Marketing.

When do you sell you produce? (Days after harvesting)	To whom do you sell your produce 1. Estate 2. Others	What are the payment conditions 1. Cash 2. Deferred

CONSTRAINTS AND POSSIBLE SOLUTIONS

19. What are the constraints you are facing in the business?

20. What action do you propose the factory to undertake to solve the above-mentioned problems?

21. What policy recommendations would you give the government in respect to the outgrower schemes and sugar industry in general?

Appendix 3: Region of origin of migrants

	Frequency	Percent
Kilimanjaro	29	59.2
Morogoro-Mgeta	5	10.2
Morogoro Kilosa	1	2.0
Bigamy	2	4.1
Kagera	1	2.0
Ludwig	2	4.1
Handeni	1	2.0
Tanga	1	2.0
Dodoma	2	4.1
Kibati	3	6.1
Mbeya	2	4.1
Total	49	100.0

Appendix 4: Acquisition of initial land and participation in outgrower scheme

Means of Land acquisition	Participation in outgrowers scheme			
	Number	No (%)	Yes (%)	Total
Leased	30	100.0		100.0
Inherited	44	50.0	50.0	100.0
Bought	39	45.2	54.8	100.0
From village	19	57.1	42.9	100.0
Others	8	27.3	72.7	100.0
Total	140	50.7	49.3	100.0

Appendix 5: Implements owned by farmers

Implement		Frequency	Percentage
Hand hoe	No	3	2.1
	Yes	137	97.9
	Total	140	100.0
Machete	No	5	3.6
	Yes	135	96.4
	Total	140	100.0
Sickle	No	93	66.4
	Yes	47	33.6
	Total	140	100.0
Forked hoe	No	134	95.7
	Yes	6	4.3
	Total	140	100.0
An axe	No	112	80.0
	Yes	28	20.0
	Total	140	100.0

Appendix 6: Employment status and major source of income

(n = 140)

Employment status	Major source of income (%)					
	Farming	Salary	Others	Farming and salary	Farming and other	Total
Self employed	-	-	50.0	-	50.0	100.0
Government employee	-	50.0	-	50.0	-	100.0
Private sector employee	-	20.0	-	80.0	-	100.0
Farmer	100.0	-	-	-	-	100.0
Total	87.9	2.1	2.9	4.3	2.9	100.0