Analysis of Technical Efficiency of Small Scale Tea Production in Nandi Hills - Nandi County: A Data Envelopment Analysis Approach

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Abstract*: Tea production has largely spread from its original land of China to so many parts of the world. Since tea was discovered in China, it has travelled the world conquering the thirsts of virtually every country on the planet. Tea is the most popular beverage in the world as well as the healthiest. It has become one of the most important economic activities to the small-scale farmers in Kenya and employs greater population in other related businesses. However, production in this sector doesn't match the high demand in the market and socio-economic sustainability of the livelihood. This study is therefore set to analyze the technical efficiency in small-scale tea production in Nandi Hills region, Nandi County and suggest the necessary measures that should be adopted by farmers to improve their production efficiency. This study was based in Nandi County from where the primary data was sourced from farmers in the field and was supplemented by secondary data that was also elicited from journals, research reports, Government reports, website among others. Purposive sampling was used to select farmers and was appended by simple random sampling to form a sample frame of 40 farmers. Data was collected from tea farmers between July and September 2014 by use of pre-tested semi-structured questionnaires administered by the researcher. Information on yields and inputs used to grow tea by each household were collected. Descriptive data analysis was used to describe qualitative data while quantitative data was also analyzed using inferential statistics both done by Data Envelopment Analysis (DEA) models. This study hypothesized that small-scale tea production is economically inefficient, and its key limitation is the time limit for the study. It also assumed that data collection and analysis were valid and reliable.DEA model was used to determine the technical relationship between inputs and outputs. The study's significance was to draw out policies and recommendations that may be provided to farmers to improve efficiency in production. The main finding is efficiency scores of tea production varied widely ranging from 0.1093750 to 1.0. Farmers who allocated small parcel of land to tea production were more efficient. Economic factors such as size of land and land allocated to tea significantly determined the level of technical efficiency of tea production in Nandi Hills.

***Key Words:* Tea Production, DEA, Technical Efficiency, Small-Scale Farmers, Nandi County**

I. INTRODUCTION

1.1 Background Information

Tea is a major cash crop that is grown in Kenya. Tea is ranked as the third major foreign exchange earner; in Kenya behind tourism and horticulture. Tea industry contributes to the livelihood of over 400,000 smallholder farmers and it provides employment to over two million people. It continues to be the main foreign exchange earner in the agricultural sector and the industry employs 75% of the rural population. Most tea produced in Kenya is black tea. However, green and white tea is produced in order by major tea producers. Tea was discovered more than 5000 years ago by an emperor ShenNung in China. Tea was first introduced in Kenya in 1903 by GWL Caine and was first planted in present day Limuru. However, commercialization of tea started in 1924 and since then Kenya can boast itself as a major producer of black tea. Kenya is one of the world's top producer and exporters of tea currently Kenya is ranked 3rd behind China and India. The task of managing the small-scale holder lies with KTDA. Kenya's tea growing regions endowed with ideal climate; tropical, volcanic red soils, well distributed rainfall ranging between 1200mm to 1400mm per annum; long sunny days are some of the climatic features of tea growing regions. Tea in Kenya is under an area over 157720 hectares, with production about 345817metric tones of made tea. Tea is sold through public auction in Mombasa. Tea in Kenya is controlled by different institutions and government bodies like Ministry of Agriculture, Tea Board of Kenya, Kenya Tea Development Agency and East African Tea Trade Association. The KTDA collects tea from tea farmers for manufacturing while TBK and EATTA help in marketing tea and do research on tea production. The Kenyan government has put more effort to ensure that tea production increases each year to maintain economic stability of the country and also decrease poverty levels among the tea farmers.

Despite these efforts, tea production especially in this sub-sector remains low more so in Nandi County where the sub-sector has continuously obtained less than 50% of what the estate sub-sectors achieve per unit area on average. Despite the small-holder planting high yielding tea clone, the national average yield in the sub-sector is 1982 kilograms compared to 3,000 kilograms in the estate sub-sector in 2010 (MOA, 2010).Most of the tea production in Nandi County is on large scale firms owned by multinationals. The rest of the tea is produced by smallholder famers who have areas under tea averaging between 1 to 5 acres per household. The County potential for growing tea stands at 30,000 ha, but the total area currently under the crop is 9,050 hectares, this represents 5.2% of the total potential of this area (KTDA, 2010).The smallholder sector has a total of 2million bushes with an average yield of 0.55kilograms of green leaf per bush per year as opposed to the national average of 1kgs of green leaf of bush per year in the sub-sector. The research achievement stands at 3.6kgs of green leaf per bush per year (Mwangi, 2010) on average. The Kenya Tea Development Authority Agency objectives are to increase production in the smallholder tea sub-sector and attain a national average of 1.5kilograms per bush per year by 2030. In Nandi County this could only be realized if the problems affecting production are identified and appropriate interventions developed to address them adequately. Therefore, improving efficiency in production allows farmers to increase their output (Chimai, 2011). Chimai also noted that for the small-holder farmers, variation in production due to differences in efficiency may be affected by various factors which include regional and farm specific socio-economic factors. Technical inefficiency may arise primarily due to managerial incompetence and therefore efficiency differences could be explained in the context of the management characteristics such as training, experience and motivation. The study sought to determine technical efficiency of tea production among smallholder farmers in Nandi Hills region, Nandi County of Rift Valley Kenya. This chapter reviews available literature that is deemed relevant for the study. In Nandi County not much has been done on efficiency of small scale tea production but in Kenya as whole and other parts of the country much has been done. There is a literature on the topic in Africa and beyond its borders.

1.2 Problem Statement

Agricultural sector being the backbone of Kenya's economy, small scale farmers must realize the importance of technical efficiency especially in tea production. In Nandi Hills region, tea is being produced in both small and large scale levels. The development of tea market trend is relatively high due to high demand observed largely in international markets. However, the efficiency of tea production is low. As a result income obtained from tea sales does not match the high demand and socio-economic sustainability livelihood of farmers who are engaging in this production as they are still enslaved in poverty. Therefore, immediate remedies should actually be availed to improve the efficiency of production.

1.3 Objectives of the Study

1.3.1 General Objective

To analyze the technical efficiency of small-scale tea production in Nandi County

1.3.2 Specific Objectives

1) To estimate technical efficiency scores of small scale tea farmers in Nandi Hills.
2) To identify the social factors that determined the level of technical efficiency of the sampled respondents.
3) To identify the economic factors that determined the level of technical efficiency of the sampled respondents.
4) To outline policy recommendation for efficient small-scale tea production

1.4 Hypotheses of the Study

The hypotheses that were tested in this study were:

H_{01} : Social factors such as gender, age, education level and family size do not significantly determine the level of technical efficiency of tea production in Nandi Hills.

H_{02} : Economic factors such as size of land and land allocated to tea significantly determined the level of technical efficiency of tea production in Nandi Hills.

H_{03} : Small-scale tea production in Nandi Hills is economically inefficient.

1.5 Assumptions of the Study

First it was assumed that the respondents were willing to give true and honest information. Secondly farmers were fully aware of all the costs incurred in producing the crop even though they may have kept limited or no record at all. The third assumption was that production of tea was done throughout the year and farmers in the area were not aware of efficiency in production sector.

1.6 Limitations and Scope of the Study

The time period allocated for this study was too short that detailed information may not have been provided.This research measured performance in tea production, decomposed performance measures into components (for example technical and allocative efficiency), identified the role models that can serve as benchmarks for programs of productivity improvement and identify the output and input changes that were necessary for farmers to achieve best practices. It also critically evaluated previous studies on farm efficiencies using DEA and stochastic frontier analysis.

1.7 Justification

Agricultural sector being a life-blood of our economy provides both direct and indirect employment to more than $80^0/_0$ of the Kenyan population. Tea production as also a key segment in agriculture plays an important role in the lives of smallholder farmers, brokers and employees in other related businesses. Tea production is labor intensive and therefore, it attracts people who seek employment and any snag that would arise in the industry would affect the economy of the locality. This was experienced mostly by the smallholder farmers who were entitled to low income hence low living standards. This study therefore focused on analyzing the technical efficiency in small-scale production and draw up the policy recommendations that can make the production efficient to farmers in Nandi County.

II. LITERATURE REVIEW

2.1 Literature Review on Tea Production

The tea industry directly and indirectly supports the livelihoods of agricultural communities and even national economy of Kenya, the sector contributes about 23 percent GDP, generates over 65% of foreign exchange and provides employment to over 75percent of the total population (GOK, 2003).

Agriculture also provides raw materials for agro-industries, which account for about 70percent of all the industries and provides over 50percent of the government budget. Tea is an important cash crop in Kenya grown in high altitude areas between 1400 and 2700 meters above sea level where rainfall ranges between 1800mm and 2500mm annually (KTDA annual report 2010).The smallholder sub-sector dominates Kenya's agricultural sector accounting for over 75% of the total production and over 48% of market production. The sub-sector accounts for the production of over 65% maize, 65% coffee, 56% tea over 80% of milk and 70% beef and other meat products. Tea is planted in the prime lands with very good soils and climate (Mogusu, 1989), thus there is need to maximize on its productivity to pay for the opportunity to pay for the opportunity cost of its substitutes.

The objective of the government is to increase tea production and realize 400,000 metric tonnes made tea per year by the year 2030. (Mwangi, 2009), a target that has been so far achieved the challenge now is to maximize production per unit area and at the same time produce high quality tea that can compete favorably well at the international markets for better earnings to the farmers. It is important to note time has come for farmers to change their perception and consider tea farming as a business and not as status symbol as it is in some tea growing areas currently. Emphasis should be put on efficient utilization of available resources mainly labor and mineral fertilizer.

The aim of this study was to identify the technical efficiency and related factors that influence tea productivity in the smallholder subsector. The results of the study may help in developing strategies that will be used to improve production in this area. Many researchers have attempted to throw light to the problem of low productivity in the smallholder tea sub-sector. Most of the pertinent works on this line of research are discussed later. To add on to the existing body of knowledge on this issue, One County was selected. It has been hypothesized that efficient use of inputs like fertilizer by farmers, intensified extension services through increased number of extension staff and improved field management according to the agronomic recommendations would improve the productivity of tea among smallholders (Ombui, 2002).

2.2 Theoretical Framework

Production theory in economics will be used in the research study. The theory involves some of the most fundamental principles of economics. A production function is a technical relationship between resource inputs and the production output. Beatle and Taylor (1985) defined production function as a quantitative or mathematical description of the various technical production possibilities faced by a firm. The function indicates maximum yield in physical terms for each level of inputs used in physical terms given to the existing technology.

Farm managers are therefore provided with a method of analyzing the level inputs and outputs so as to be able to use their resources effectively and efficiently. The farmers make use of the production function to get diagnostic results in their farms and be able to make proper suggestions and decisions. The production function is given by;

$$Y = f(X_1, X_2 \ldots\ldots\ldots\ldots\ldots\ldots X_n)$$

2.3 Literature Review on Economic Efficiency

In production, economic efficiency is a combination of technical and allocation efficiency respectively. It aims at maximizing benefits while minimizing costs incurred in production. According to Barr, (2004), economic efficiency is the same as Pareto efficiency. Allocation of resource is Pareto efficiency if no one individual can be better-off without making someone (or another activity) else worse-off. Hardwick *et al.,* (1988) proposed the concept of Pareto efficiency can be used to evaluate different ways of allocation resources. To improve the community welfare, Sen (1993), farmers should ensure effective allocation resource that makes at least one activity better off without making any other activity worse off hence, Pareto improvement. However, Pareto improvement is hampered by three basic decision making problem facing the farmers: Choice of variables; this refers to the decision variables whose values are chosen by the agents. `In this case farmers have to make a choice of the quantities of input to be used to achieve the desired output. Secondly, is the restriction; this will refer to the set of achievable values for which to choose from. The input-output selected by the firm must be feasible.

Lastly, it is the creation of choice that assigns different values to the outcome from alternative decisions. In addition, the low productivity in tea all over the world, including Nandi Hills is due to the inability of farmers to fully exploit the available technologies, resulting in lower efficiencies of production (Kalirajan 1981; 1982, Bagi, 1982; Batleses and Coelli, 1988; Anjama etal1996).Farmers tend not to adopt the available hybrid seeds and pest, disease and nutrient management technologies.

Manescu, (1974) indicates that though sufficient information on the status of the allocation and technical efficiencies is available in production sector including Nandi County and other parts of the country, very little attention is paid to the economic efficiency in tea production due to influence of strong cultural practices and literacy level of farmers . Furthermore, in Bangladesh, Uddin *et al.,* (2010) did an economic analysis in different production system. It was observed that the small scale farmers faced the problems of high input prices and low prices of output and high opportunity cost for own factors of production (land, family, labor and capital). He observed that capital and labor had a bigger share in cost of production and concluded that farmers needed to find ways of reducing costs and increasing returns in order to be more competitive.

In order to provide a holistic solution, (European Commission, 2002) European Union also made the policy of allowing Agricultural sector to be more competitive and market oriented. In this context, the improvement of farm efficiency was fundamental and the measurement of existing inefficiencies in terms of profitability in the agricultural production becomes much more useful especially in small production.

Ali and Chaundry (1990) defined allocation efficiencies as the ability to contrive an optimal allocation of the given resources. It can be expressed as the ratio of the technically maximum possible output obtainable at optimum resource level. The failure of farmers to utilize profit maximizing level of input is defined as "allocation inefficiency" (Herdt and Mandac, 1981). Allocation inefficiency may result in substantial loses, if estimated in terms of output but profit loss may be insignificant because of incremental input cost required to correct allocation errors. Their analysis showed that the output loss due to allocation inefficiency ranged from $25^0/_0$ to $35^0/_0$ while profit loss to $2^0/_o$. Measures of efficiency help in achieving improvement in performance of productivity. Farell (1951) also stated that measuring efficiency profitability allows us to determine whether output can be increased by raising efficiency without increasing inputs quantities.

Murthy, (2009) carried out a study economic efficiency and its determinants in Karnataka, India and used Data Envelopment Analysis Approach in analyzing the data. The result showed that land and labour have turned out to be most critical in impacting the economic efficiency would provide the higher production yield. In addition to this variables, education, technical and credit facilities were also in improving the efficiency of production

2.4 Literature Review on Technical Efficiency

The domestic productions in most African countries lag behind the demand and yields levels of many crops are below the global averages. The scarcity of land and other production resources necessitate a strategy to increase agricultural productivity by efficiently using the few available resources. This reveals the importance of technical efficiency and its linkage with agriculture. In the same ways, many authors (Choina, 2011; Fried *et al.,* 2008; Coelli *et al., 2002*) have recognized the crucial role of technical efficiency in productivity and agricultural growth.

In a production frontier, a technically efficient farmer is always located on the frontier while the inefficient farmer at the anterior (Coelli *et al.*, 2002). One way of reducing the cost of production in a farm is to increase farm output by increasing technical efficiency (Fried *et al.*, 2008). In this regard, it is necessary to quantify current levels of technical efficiency of farmers in order to estimate the losses in production attributed to inefficiency due to different socio-economic characteristics and management practices.

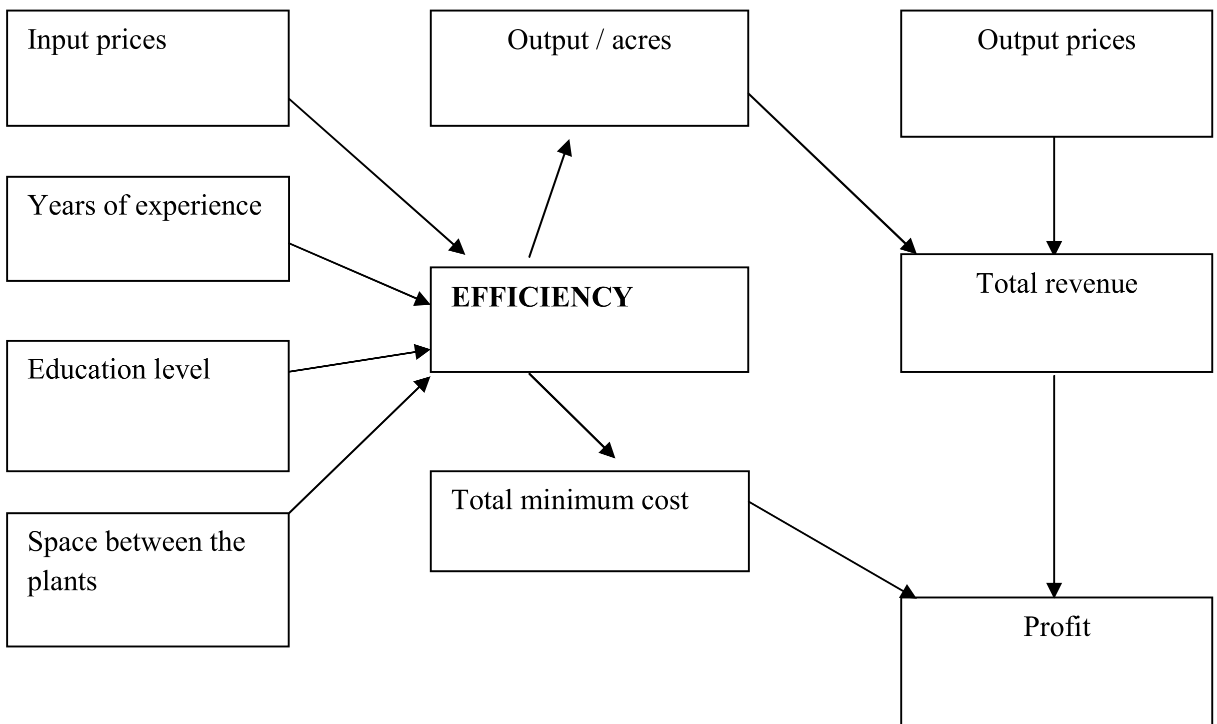
There is a growing body of literature on technical efficiency, using different approaches, in African agriculture so far. Literature (Fried *et al.,* 2008; Coelli *et al.,* 2002; Charnes *et al.,* 1978) suggests several alternative approaches to measure technical efficiency. Using these approaches TE studies have been conducted on various crops such as maize, wheat, millet, Irish potatoes, coffee, millet and sorghum. Most of these studies however have reported low to moderate technical efficiencies ranging from as low as 0.24. This confirms the evidence that most countries in the developing world in general and Sub Saharan Africa (SSA) in particular still experience relatively low efficiency levels in agriculture. These approaches are normally grouped into nonparametric, Data Envelopment Analysis (DEA) being the most commonly used and parametric frontiers, Stochastic Frontier Analysis (SFA) being the most commonly used.

A non- parametric, DEA model was used in this article. As pointed out by various authors (see for example, Chimai, 2011; Chiona, 2011; Abu, 2011; Yusuf and Malomo, 2007; Coelli *et al.*, 2002; Charnes *et al.*, 1978), DEA approach has several advantages. It uses mathematical programming to measure relative efficiency of DMUs. It does not make priori assumptions about the functional form of the production function and the inefficiency term. Instead it makes general assumptions of monotonicity and convexity, which result in a flexible frontier that allows the production function to vary across DMUs. Few empirical studies have argued on the disadvantages of DEA. One of the disadvantages lies in its deterministic nature where it fails to account for stochastic noise in data, which could be a potential bias to the estimated efficiency scores. Another disadvantage is that it is less robust to outliers and extreme values. However, a large number of empirical studies have extended and applied the DEA technology in the study of efficiency worldwide (Chimai, 2011; Abu, 2011; Chiona, 2011; Mussa *et al.*, 2011; Javed *et al.,* 2010; Yusuf and Malomo, 2007; Chavas *et al.*, 2005; Donthu and Yoo, 1998).

2.5 Conceptual Framework

In assessing efficiency of an agricultural enterprise, different variables are always considered in relation to their relevance to the particular topic and enterprise under study. This research study has the aim of assessing the technical efficiency of tea production among the small holder farmers in Nandi Hills region, Nandi County. Figure 2.1 presents the conceptual framework.

Figure 2.1: Variables in Relation to their Efficiency in Tea Production.



Source: Author's Conceptualization, 2015

In the above graphic, labour cost, years of experience, education level and the space between plants are among noble factors that determine the quantity and efficient combination of input which enable maximization of output. Total revenue determined at prevailing output market price. The total minimum cost is the cost incurred when production is efficient. The difference between total revenue and total cost is the maximum profit.

III. RESEARCH METHODOLOGY

3.1 The Study Area

Nandi Hills region is a highland area of lush green rolling hills at the edge of the Great Rift Valley in the Rift Valley Province of Kenya. This region borders the following counties; Uasin Gishu to the North and East, Kericho to the South East, Kisumu to the South, Vihiga to the South West and Kakamega to the West. It is located near the edge of the Rift Valley, it is a home to Kenya's tea plantations. Its high altitude plays a major role in athletics in Kenya where every morning international athletes are seen running up and down the hills, through the tea estates. Its geographical coordinates are 0^0 70'0" north, $35^0$11'0" east. Agriculture in the study area is mainly rain fed.

The climatic condition of the region is cool and wet with two rainy seasons during the equinoxes. Temperatures vary between 18^{o}C and 24^{o}C which coupled with the rich volcanic soils make the area ideal for growing tea. Its rainfall amounts range between 1200mm and 2000mm per annum.

The region has a total population of approximately 752,965(male 50%, female 50%). The region experience a bimodal wet-dry precipitation pattern, with wet seasons near equinoxes, when the sun is farther from the equator, and dry seasons in between, when the sun is more directly overhead.

3.3 Sampling Design and Data Collection

The population of interest comprised of tea growing households. A sample size of 40 farm households was determined proportionately using total population of the county. Two forms of sampling procedures were employed. First, tea farmers were selected using purposive sampling method in the county and the selected farm households were subjected simple random sampling where all farmers were selected to achieve the required sample size. Data was collected from tea farmers between July and September 2014 by use of questionnaires.

3.4 Sample Frame and Size

The sample frame was small- scale tea farmers in Nandi Hills region. A sample of 40 farmers was selected from the randomly chosen location using simple random sampling.

3.5 Target Population

The target population for this study was small-scale tea farmers in Nandi Hills region, Nandi County from whom the primary data was sourced.

3.6 Theoretical Framework of the Study

This study was basically based on the micro-economic theory where the households' main objective was the optimality of output to ensure profit maximization which was achieved through efficient use of available scarce resources. Efficiency encompasses improving the observed to attain the optimum level of output with minimum cost and inputs. The economic efficiency could only be achieved when farmers were technically and allocatively efficient in their production to maximize benefit.

Allocation efficiency involved farmers using the right mix of inputs that gave higher quantity of output at minimum cost and technical efficiency was also where maximum output was achieved using minimum inputs possible given the technologies applied. Therefore, both allocation and technical efficiency gave rise to economic efficiency.

3.7Types and Sources of Data

Primary data was obtained and analysed to achieve the aims of study.

3.8 Primary Data Types and Sources

The main type of data for this study was primary data, this was the information that was collected from the farmers using the semi-structured questionnaire and included; Age, Gender, experience in tea production, Education, Price of input selling price, income of from farm, farm size, spacing of plants (distance between plants)

3.9 Data Analysis

This study used Data Envelopment Analysis (DEA) model to analyze data. The model involves use of linear programming methods to conduct a non-parametric piecewise surface (or frontier) over the data to calculate efficiencies relative to this surface (Coelli *et al*., 2002). DEA can either be Constant Return to Scale (CRS) or Variable Return to Scale (VRS). CRS is appropriate when all Decision Making Units (DMUs) are assumed to be operating at an optimal scale, or otherwise VRS is appropriate. Tea farmers in the study area experience variations in agricultural production occasioned by factors such as financial constraints, imperfect competition, fluctuating input prices and unreliable labor supply. The use of VRS was assumed appropriate in order to account for these variations. Technical efficiency was estimated based on output-orientation where a household produces maximum output given a level of inputs and it determines the maximum proportional increase in output produced with inputs level held fixed. In DEA the performance of a farm is evaluated in terms of its ability to either shrink usage of an input or expand the output level subject to restrictions imposed by the best observed practices (Gul *et al*., 2009).

All the DMUs with a score of 1 were regarded as being technically efficient, while all the others with scores of less than 1 were regarded as technically inefficient.

Technical efficiency indices (TEIs) are the efficiency measures obtained from ratios of sums of weighted outputs to the sums of weighted inputs. In DEA these efficiency indices are generated as radial measures based on Farrell's (1957) concept. The radial measures can be radial contraction of inputs to the least level necessary for production of a specific level of output or expansion of outputs obtained from a given combination of inputs (Farrell, 1957). DEA constructs a piece-wise frontier enveloping most DMUs in the sample. In output orientation, the frontier is constructed based on the DMUs that are furthest from the origin. This is because the further they are the greater the ability to produce more from a fixed set of inputs and are therefore on a higher production possibility frontier (Coelli, 1996). This measure of performance is relative in the sense that the efficiency of each DMU is evaluated against the most efficient DMU. It is measured by the ratio of the actual output to maximal potential output. A DMU can be rated as fully (100%) efficient on the basis of available evidence if and only if the performance of the other DMUs does not show that some of its inputs or outputs can be improved without worsening the others inputs or outputs (Coelli *et al.,* 2002). The other DMUs with less than 100% technical efficiency score were rated as being inefficient.

IV. RESULTS AND DISCUSSIONS

4.1 General Response

Data from the field was sourced from the farmers by administering questionnaires. Farmers were very willing to give the information without any hesitation. Interestingly, a good number of the respondents were literate and so getting the questionnaires filled was an easy task. The information on the following variables was collected; Gender, Age, Education level, Amount of fertiliser and pesticide used, Type of labour used, Years of experience and Price of tea per kilogram. This information formed the ground of substantiating the impact of the above variables on technical efficiency of producing tea in small-scale.

4.1.1 Gender of Respondents

Table 4.1 Gender of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	28	70.0	70.0	70.0
	Female	12	30.0	30.0	100.0
	Total	40	100.0	100.0	

Source: Data Analysis Results, 2015

Majority of the respondents are male as shown in the above table represented by 70% with a frequency of 28. The remaining 30% represented female with a frequency of 12. This information basically suggests that farming in this region is a male thing, furthermore, the main factor of production which in this case is land is traditionally owned by men. Tea production is mainly done by men, who predominantly struggled to be economically efficient in their production. This is true in that, the men principally knew the prices of inputs like fertilizers and pesticides while female were generally uninformed. Output prices, that's the price of tea was also men concern as in fact they are the bread winners of most families. The input and output prices are of great concern as these are the indicators of whether the production is economic efficient or not.

4.1.2 Age of Respondents

Table 4.2 Age of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 30	2	5.0	5.0	5.0
	31-40	19	47.5	47.5	52.5
	41-50	7	17.5	17.5	70.0
	Above 50	12	30.0	30.0	100.0
	Total	40	100.0	100.0	

Source: Data Analysis Results, 2015

From the analysis, the largest percentage of the farmers in the region lies between the ages of 31-40 years which is represented by 47.5%. It is followed by the age group of above 50 years with the percentage of 30% who have experience in tea production. The age group between 41-50 years is represented by 17.5% and those below 30 years are 5%, these are the youths who have interest in tea production.

4.1.3 Farmers Education

Table 4.3 Farmers Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary	24	60.0	60.0	60.0
	Secondary	10	25.0	25.0	85.0
	Tertiary	4	10.0	10.0	95.0
	none	2	5.0	5.0	100.0
	Total	40	100.0	100.0	

Source: Data Analysis Results, 2015

The findings show that, the highest percentage of the farmers in this region have gone through primary education represented by 60.0% This is followed by secondary education and tertiary with 25.0% and 10.0% respectively. The remaining 5.0% have attended not attended school. Generally, those in the higher level of education are efficient in production and it reduces with the decrease in education level.

Table 4.4 Types of Farming

		Frequency	Percent	Valid Percent	Cumulative Percent
	Mixed	36	90.0	90.0	90.0
	Mono-Cropping	4	10.0	10.0	100.0
	Total	40	100.0	100.0	

Source: Data Analysis Results, 2015

In this region, most of the farmers practice mixed farming as shown above with a portion of 90.0%.This shows that they have diversified their resources in different production activities due to land scarcity and for subsistence purposes. The remaining 10.0% do mono-cropping in teaas the only cash crop and buy the other farm products from the market for consumption.

Table 4.5 Sources of Capital

		Frequency	Percent	Valid Percent	Cumulative Percent
	Own savings	20	50.0	50.0	50.0
	Loan	8	20.0	20.0	70.0
	Inheritance from relatives	12	30.0	30.0	100.0
	Total	40	100.0	100.0	

Source: Data Analysis Results, 2015

From the analysis, most of the farmers represented by 50% started the tea production from their own savings, 30% inherited from their relatives and 20% borrowed loan. This trend shows that most of the people always make sufficient plans before beginning production and just a few who lack funds may borrow loan to boost them in buying inputs or for land preparations.

4.1.4 Years of Experience

Table 4.6 Years of Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
	0-5 years	13	32.5	32.5	32.5
	6-10 years	16	40.0	40.0	72.5
	11-15 years	2	5.0	5.0	77.5
	16-20 years	4	10.0	10.0	87.5
	>25 years	5	12.5	12.5	100.0
	Total	40	100.0	100.0	

Source: Data Analysis Results, 2015

Majority of the respondents had the years of experience ranging between 6-10years and 0-5 years represented by 40.0% and 32.5% respectively. The rest had years of experience between 11-15 years, 16-20 years and over 25 years represented by 5.0%, 10.0% and 12.5% respectively. This analysis shows that most farmers have just little years of experience in this region and those with more experience in production are few.

4.2 Results of Estimated Technical Efficiency Scores

4.2.1 Results of Input Oriented Technical Efficiency (FDHIO)

The results of input output orientation is reported in table 4.7. The results show that the level of input- oriented technical efficiency was heterogeneous. The results showed that farmer number DMU 2, 3, 9, 11, 16, 19,20, 28, and 36 were technically efficient. DMU 2 and DMU 3 had land allocated to tea of 6 and 5 acres respectively. The results showed that small scale farms were technically efficient.

Table. 4.7 Results of Input Output Oriented Technical Efficiency

DMUs	Efficiencies	DMUs	Efficiencies
1	0.1968912	21	0.1414141
2	1.0000000	22	0.2485207
3	1.0000000	23	0.2574055
4	0.2748092	24	0.1093750
5	0.3323823	25	0.2517483
6	0.2103506	26	0.5431034
7	0.6086957	27	0.8597786
8	0.3307087	28	1.0000000
9	1.0000000	29	0.1906203
10	0.1218569	30	0.3646889
11	1.0000000	31	0.3585859
12	0.8597786	32	0.3981043
13	0.2245989	33	0.1240157
14	0.1915966	34	0.4902724
15	0.5959079	35	0.4772727
16	1.0000000	36	1.0000000
17	0.3368984	37	0.8597786
18	0.2763158	38	0.1853659
19	1.0000000	39	0.5985748
20	1.0000000	40	0.1111111

Source: Data Analysis Results, 2015

The other technically efficient farmers had allocated to tea production ranging from 0.1 to 0.4 acres. Based on this finding it was concluded that small scale farms are technically efficient. The least technically efficient farm is DMU 24 and had allocated 0.5 acres to tea production.

4.2.2 Results of Inverted Input Oriented Technical Efficiency (FDHOO)

The results of inverted input oriented technical efficiency (FDHOO) are presented in table 4.8.

Table 4.8 Results of inverted input output oriented technical efficiency

DMUs	Efficiencies	DMUs	Efficiencies
1	0.1222222	21	0.5432099
2	1.0000000	22	0.2987654
3	1.0000000	23	0.2444444
4	0.4074074	24	0.7061728
5	0.1901235	25	0.2172840
6	0.2716049	26	0.2172840
7	0.2172840	27	0.1901235
8	0.4481481	28	1.0000000
9	1.0000000	29	0.3666667
10	0.2716049	30	0.3259259
11	1.0000000	31	0.2400000
12	0.1629630	32	0.2444444
13	0.3259259	33	0.6790123
14	0.1086420	34	0.3530864
15	0.2037037	35	0.2308642
16	1.0000000	36	1.0000000
17	0.3666667	37	0.1901235
18	0.3111111	38	0.1086420
19	1.0000000	39	0.2172840
20	1.0000000	40	0.9506173

Source: Data Analysis Results, 2015

The results of inverted input-output orientation are reported in table 4.8. For the output-oriented analysis, the factor by which output could be increased with no additional input was calculated. The reciprocal of that factor was taken. The results revealed that the level of inverted input- oriented technical efficiency was also heterogeneous. The results showed that farmer number DMU 2, 3, 9, 11, 16, 19, 20, 28, and 36 are technically efficient. DMU 2 and DMU 3 had land allocated to tea of 6 and 5 acres respectively. The other technically efficient farmers had allocated land to tea production ranging from 0.1 to 0.4 acres. Based on this finding it is also concluded that small scale farms were technically efficient.

4.2.3 Results of Input Oriented Technical Efficiency with Variable Returns to Scale (VRIO)

Tables 4.9and 4.10presents the results of output oriented technical efficiency.

Table 4.9 Results of Output Oriented Technical Efficiency

DMUs	Efficiencies	Lambda1	Lambda16	DMUs	Efficiencies	Lambda1	Lambda16
1	0.13649089	0.000000	0.95564516	21	0.09090155	0.000000	0.40731183
2	1.00000000	1.000000	0.00000000	22	0.11224576	0.000000	0.76344086
3	0.52785703	0.388888	0.00000000	23	0.10532472	0.000000	0.82258065
4	0.14746544	0.000000	0.64516129	24	0.08424456	0.000000	0.31989247
5	0.13182397	0.000000	0.88172043	25	0.09766309	0.000000	0.85215054
6	0.09053844	0.000000	0.79301075	26	0.21069128	0.000000	0.85215054
7	0.23613708	0.000000	0.85215054	27	0.34099115	0.000000	0.8817043
8	0.18799742	0.000000	0.60080645	28	0.69323005	0.000000	0.95564516
9	0.67524216	0.000000	0.94086022	29	0.09621602	0.000000	0.68951913
10	0.05244925	0.000000	0.79302075	30	0.17245927	0.000000	0.73387097
11	0.39430082	0.000000	0.92607527	31	0.35858586	0.000000	1.00000000
12	0.32124152	0.000000	0.91129032	32	0.16289558	0.000000	0.82258065
13	0.10621155	0.000000	0.73387097	33	0.09288746	0.000000	0.34946237
14	0.12832294	0.000000	0.97043011	34	0.24225974	0.000000	0.70430108
15	0.24318332	0.000000	0.86693548	35	0.19022127	0.000000	0.83736559
16	1.00000000	0.000000	1.00000000	36	1.00000000	0.000000	0.00000000
17	0.17005024	0.000000	0.17005024	37	0.34099115	0.000000	0.88172043
18	0.12746711	0.000000	0.75000000	38	0.12414984	0.000000	0.97043011
19	0.40808874	0.000000	0.86693548	39	0.23221081	0.000000	0.85215054
20	0.75179669	0.000000	0.98521505	40	0.10682047	0.000000	0.05376344

Source: Data Analysis Results, 2015

In this matrix, efficiency is (pure) input-oriented technical efficiency. Lambda1to lambda 40 was weights on DMU 1 to DMU 40 used to construct points on the Variable Returns to Scale efficient frontier. (The lambdas in each row sum to one.) Thus the efficiency for DMU 5 was 0.1183. The slack was zero and represented the amount by which output could be increased after a DMU reduces its input to the minimum required for its initial output. As expected this slack was non-negative. It was strictly positive only where the frontier allowed for increases in output without increasing input.

Table 4.10 Results of Input Output Oriented Technical Efficiency

DMUs	Efficiencies	Lambda35	Lambda40	DMUs	Efficiencies	Lambda35	Lambda40
1	0.13649089	0.04435484	0.000000	21	0.09090155	0.50268817	0.000000
2	1.00000000	0.00000000	0.000000	22	0.11224576	0.23655914	0.000000
3	0.52785703	0.61111111	0.000000	23	0.10532472	0.17741935	0.000000
4	0.14746544	0.35483871	0.000000	24	0.08424456	0.68010753	0.000000
5	0.13182397	0.11827957	0.000000	25	0.09766309	0.14784946	0.000000
6	0.09053844	0.20698925	0.000000	26	0.21069128	0.14784946	0.000000
7	0.23613708	0.14784946	0.000000	27	0.34099115	0.11827957	0.000000
8	0.18799742	0.39919355	0.000000	28	0.69323005	0.04435484	0.000000
9	0.67524216	0.05913978	0.000000	29	0.09621602	0.31048387	0.000000
10	0.05244925	0.20698925	0.000000	30	0.17245927	0.26612903	0.000000
11	0.39430082	0.07392473	0.000000	31	0.35858586	0.00000000	47520
12	0.32124152	0.08870968	0.000000	32	0.16289558	0.17741935	0.000000
13	0.10621155	0.26612903	0.000000	33	0.09288746	0.65053763	0.000000
14	0.12832294	0.02956989	0.000000	34	0.24225974	0.29569892	0.000000
15	0.24318332	0.13306452	0.000000	35	0.19022127	0.16263441	0.000000
16	1.00000000	0.00000000	0.000000	36	1.00000000	1.00000000	0.000000
17	0.17005024	0.31048387	0.000000	37	0.34099115	0.11827957	0.000000
18	0.12746711	0.25000000	0.000000	38	0.12414984	0.02956989	0.000000
19	0.40808874	0.13306452	0.000000	39	0.23221081	0.14784946	0.000000
20	0.75179669	0.01478495	0.000000	40	0.10682047	0.94623656	0.000000

Source: Data Analysis Results, 2015

4.2.4 Results of Output-Oriented Analysis (VROO), Input-Oriented Analysis (CRIO) and Output-Oriented Analysis (CROO)

The results of DEA analysis with variable returns to scale are in table 4.11. The output matrix, efficiency is the factor by which a DMU could increase its output without increasing input. The reciprocal of efficiency is (pure) output-oriented technical efficiency. Lambda1 to lambda 40 are again weights used to construct points on the VRS efficient frontier. For example, the output-oriented technical efficiency of DMU 1 was 0.8965 for VROO, 0.1222 for CRIO and 2.2976 for CROO. Similar interpretations apply to the other DMU units. The slacks are all zero in this case because once the DMUs increase output to the efficient frontier, they cannot reduce input.

Table 4.11 Results of Output-Oriented Analysis (VROO) , Input-Oriented Analysis (CRIO) and Output-Oriented Analysis (CROO)

DMUs	VROO	CRIO	CROO	DMUs	VROO	CRIO	CROO
1	0.8964535	0.12222222	2.2976190	21	0.5155161	0.54320988	7.0714286
2	0.0000000	1.22222222	13.5317460	22	0.7587080	0.29876543	4.0238095
3	0.1918936	1.08641975	11.1269841	23	0.7697910	0.24444444	3.8849206
4	0.7894237	0.40740774	3.6388889	24	0.3502217	0.70617284	9.1428571
5	0.8578214	0.19012346	2.7817460	25	0.7628246	0.21728395	3.9722222
6	0.7004433	0.27160494	4.7539683	26	0.9328689	0.21728395	1.8412698
7	0.9487017	0.21728395	1.6428571	27	0.8839835	0.19012346	1.0753968
8	0.8385054	0.44814815	3.0238095	28	0.2375691	0.12222222	0.4523810
9	0.2762431	0.13580247	0.4801587	29	0.6611780	0.36666667	5.2460317
10	0.4249525	0.27160494	8.2063492	30	0.8609880	0.32592593	2.7420635
11	0.7900552	0.14938272	0.8492063	31	0.7016575	0.03259259	0.7857143
12	0.9939835	0.16296296	1.0753968	32	0.8793540	0.24444444	2.5119048
13	0.7245092	0.32592593	4.4523810	33	0.4363521	0.67901235	8.0634921
14	0.8913870	0.10864198	2.3611111	34	0.9170361	0.35308642	2.0396825
15	0.9559848	0.20370370	1.5515873	35	0.9126029	0.23086420	2.0952381
16	0.0000000	0.08148148	0.2817460	36	1.0000000	1.00000000	1.0000000
17	0.8429386	0.36666667	2.9682540	37	0.9939835	0.19012346	1.0753968
18	0.7910070	0.31111111	3.6190476	38	0.8850538	0.10864198	2.4404762
19	0.8950276	0.20370370	0.9246032	39	0.9464851	0.21728395	1.6706349
20	0.1491713	0.09506173	0.3888889	40	0.3616213	0.95061728	9.0000000

Source: Data Analysis Results, 2015

For the CRIO results, efficiency was input-oriented technical efficiency under CRS assumption. Lambda1 to lambda 40 are weights on DMU 1DMU 40 that were used to construct points on the CRS efficient frontier. Because only DMU 2 is on this frontier, only lambda 36 is positive; all other lambdas were zero.

The row sum of lambdas in this input-oriented case was 1 for the DMU producing output at the level at which CRS begins, less than 1 for the DMU producing less than that output (i.e., the DMU with increasing returns) and greater than 1 if DMUs produces more than that output. Slacks are all zero under CRS assumption. The efficiency in this case was the factor by which output could be increased with no additional input under the CRS assumption. The reciprocal of efficiency is output-oriented technical efficiency (Input-oriented and output-oriented technical efficiency are equal under the CRS assumption.)

The CROO results for Lambda1 to lambda 40were again weights on DMU 1, to DMU 40 used to construct points on the CRS efficient frontier. The lambdas in this output-oriented case are less than 1 showing that all the DMU units were not efficient. The DMU using input at the level at which CRS were less than 1 for the DMU using less input, and greater than 1 for the DMUs using more inputs.

4.2.5 Results of Input-Oriented Scale Efficiency (SEIO) and Output-Oriented Scale Efficiency (SEOO)

If returns to scale are variable, scale efficiency was calculated by comparing technical efficiency measured under the CRS assumption to' pure technical efficiency measured under the VRS assumption. Input-oriented scale efficiency is the ratio of input required under the CRS assumption to input required under the VRS assumption. That is equivalent to the ratio of technical efficiency under the CRS assumption to pure technical efficiency under the VRS assumption. This was calculated and result showed that the values of SEIO ranged between 0 and 1. DMU 36 was efficient (SEIO value was 1).

When returns to scale are variable, scale efficiency was calculated by comparing technical efficiency measured under the CRS assumption to pure technical efficiency measured under the VRS assumption. Output-oriented scale efficiency is the ratio of output possible under the VRS assumption to output possible under the CRS assumption, that is equivalent to the ratio of technical efficiency under the CRS assumption to pure technical efficiency under the VRS assumption. This was calculated and result showed that the values of SEOO ranged between 0 and 1. DMU 36 was efficient (SEOO value was 1).

Table 4.12 Results of Input-Oriented Scale Efficiency (SEIO) and Output-Oriented Scale Efficiency (SEOO)

DMUs	Efficiencies	SEIO	SEOO	DMUs	Efficiencies	SEIO	SEOO
1	0.13649089	0.38973417	0.44524803	21	0.09090155	0.84506325	0.15663922
2	1.00000000	0.09032258	0.09032258	22	0.11224576	0.66148953	0.26184650
3	0.52785703	0.18497110	0.10601068	23	0.10532472	0.59740341	0.27057375
4	0.14746544	0.75922392	0.28766878	24	0.08424456	0.91682663	0.12516822
5	0.13182397	0.51847025	0.37084451	25	0.09766309	0.56009752	0.26501681
6	0.09053844	0.63102762	0.22435323	26	0.21069128	0.56009752	0.55120548
7	0.23613708	0.56009752	0.61563455	27	0.34099115	0.51847025	0.93113255
8	0.18799742	0.78834314	0.34257703	28	0.69323005	0.38973417	0.66247940
9	0.67524216	0.41885460	0.69813555	29	0.09621602	0.72642891	0.20497279
10	0.05244925	0.63102762	0.13742875	30	0.17245927	0.68921522	0.37595467
11	0.39430082	0.44612795	0.95048966	31	0.35858586	0.11568075	0.92395781
12	0.32124152	0.47172456	0.93113255	32	0.16289558	0.59740341	0.40877753
13	0.10621155	0.68921522	0.23834892	33	0.09288746	0.90656184	0.13954935
14	0.12832294	0.35857245	0.43375182	34	0.24225974	0.71455752	0.49931124
15	0.24318332	0.53986967	0.65080525	35	0.19022127	0.57924746	0.48654212
16	1.00000000	0.28920188	0.28920188	36	1.00000000	1.00000000	1.00000000
17	0.17005024	0.72642891	0.34865701	37	0.34099115	0.51847025	0.93113255
18	0.12746711	0.67440860	0.28914870	38	0.12414984	0.35857245	0.42022274
19	0.40808874	0.53986967	0.97726349	39	0.23221081	0.56009752	0.60569319
20	0.75179669	0.32514701	0.56185214	40	0.10682047	0.98880062	0.12687355

Source: Data Analysis Results, 2015

4.3 Stochastic Frontier Regression Analysis Results

The results of stochastic frontier regression analysis are reported in table 4.13. Regression reached convergence after two iterations with log likelihood of -119.091 which was as expected a small large number. The Wald χ^2 was 62.29 and the modeled variables fitted the regression model very well (p – value 0.000 < 0.05).These results showed that gender and family size significantly determined efficiency in tea production in Nandi Hills. Gender had a negative and significant effect on efficiency of small scale tea production in Nandi Hills (p – value 0.031 < 0.05). Family size had a positive and significant effect on efficiency of small-scale tea production in Nandi Hills (p – value 0.000 < 0.05). The first hypothesis of this study stated that social factors such as gender, age, education level and family size do not significantly determine the level of technical efficiency of small scale tea production in Nandi Hills. The results showed that gender and family size significantly determined efficiency of tea production in Nandi Hills. Based on these findings the first hypothesis was rejected.

This study sought to determine if economic factors such as size of land and land allocated to tea significantly determined the level of technical efficiency of small scale tea production in Nandi Hills. The results showed that land size had a positive and significant effect on efficiency of small scale tea production in Nandi Hills (p- value 0.024 < 0.05). The second hypothesis of this study stated that economic factors such as size of land and land allocated to tea do not significantly determine the level of technical efficiency of tea production in Nandi Hills. Based on these findings the second hypothesis was rejected. It was therefore concluded that economic factors such as size of land and land allocated to tea significantly determined the level of technical efficiency of tea production in Nandi Hills.

Table 4.13 Stochastic Frontier Regression Results

Variable	Coef	Std. Err	Z	P > |Z|
Gender	-4.8532	2.2541	-2.15	0.031
Age	-1.3612	1.1547	-1.18	0.238
Education Level	0.2286	1.0457	0.22	0.827
Family Size	2.0123	0.4528	4.44	0.000
Other Occupations	1.5524	1.0135	1.53	0.126
Land Size	8.2963	3.6865	2.25	0.024
Faming Type	2.7892	4.1202	0.68	0.498
Land Allocated to tea	0.6020	0.9677	0.62	0.534

Constant	-8.1710	9.5080	-0.86	0.390
/Insigma2v	3.1167	0.2240	13.91	0.000
/Insigma2u	-5.4868	204.0595	-0.03	0.979
Sigma_ v	4.7509	0.5322		
Sigma_ u	0.0644	5.5656		
Sigma 2	22.5750	5.0763		
Lambda	0.0135	6.6190		

Source: Data Analysis Results, 2015

V. SUMMARY OF FINDINGS AND CONCLUSION

5.1 Summary of Findings

The main finding is efficiency of tea production varies widely ranging from 0.1093750 to 1.0. Farmers who allocate small parcel of land to tea production are more efficient. The results showed that gender and family size significantly determine efficiency in tea production in Nandi Hills. The results also show that land size has a positive and significant effect on efficiency of small scale tea production in Nandi Hills (p - value 0.024 < 0.05). It is therefore concluded that economic factors such as size of land and land allocated to tea significantly determine the level of technical efficiency of tea production in Nandi Hills. The efficiency of small scale and large scale tea farms using a stochastic frontier approach has shown that there is considerable variation in efficiency among them. The average efficiency of small farms is higher than that of large farms. The extent of inefficiencies is found to be higher in large farms as compared with small farms, those farmers who had allocated less than one acre of land to tea production. This may have been driven by the significant variations in input use and output realized in addition to the variation in farm size and education level of the farmer. The results should provide useful insights to the policy makers and Government for expanding small scale tea production with the goal of improving farm income levels as well as benefiting the environment.

5.2 Conclusion

This study empirically estimated technical efficiency of tea production farmers and also identified the socio-economic factors that determine the level of estimated technical efficiency of the sampled respondents. Results indicate that the mean technical efficiency of the sampled respondents far and wide ranged from 0.1094 to 1 from the respective efficiency values for each of the tea farmers.

The direct variable (inputs), which increase efficiency of tea production was family size (p – value 0.000 < 0.05). The overall stochastic /Insigma2v is also positive and significant ((p – value 0.000 < 0.05). This implies that the combined effects of gender, age, education level, family size, other occupation, land size in acres, type of farming and land allocated to tea are expected to bring about a substantial increase in efficiency of tea production in Nandi Hills. This also means that consistent availability of these variables ensure commensurate efficiency in tea production in Nandi Hills.

Results from the socio-economic characteristics of the respondents in the study area shows that men currently dominated tea production.

Results also show that tea farmers without other occupations are more efficient than those who had other occupations and treated tea farming as a secondary occupation. The implication of the results is that increased and sustainable tea production would better be achieved through farmers without other occupations who can devote their full time to tea production. Although, the small-scale tea farmers were found to be generally fairly efficient, there is room for improvement in the use of available resources under a guaranteed and conducive environment. This also implies that small scale tea production could be used as a strategy to create more employment to generate income for majority of farmers which in turn will improve their livelihoods.

5.3 Recommendation

There is need to improve the level of awareness of better techniques of tea production in Nandi Hills. This is expected to increase tea production. Gender determines efficiency of tea production. Therefore policy makers should design policies that are gender sensitive to promote efficiency in tea production. The findings should provide useful insights to the Kenya Government for expanding small scale tea production with the goal of improving farm income levels. Land size determines efficiency of tea production. Therefore, policy makers should design policies that promote land consolidation and discourage land fragmentation.

5.4 Suggestions for Future Research

Owing to limitations and scope of this study the following areas are suggested for future research: There is need for a research to be done to determine the contribution of education level to the technical efficiency. There is also need for Environmental Impact Quotient (EIQ) analysis to determine if small scale tea production have a lower EIQ than the large scale tea production farms, and indicate reduced damage to the environment. This research covered Nandi Hills, there is need to replicate a similar research to cover a larger geographical and larger number of respondents so that its findings can be confirmed.

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STATA OUTPUT STOCHASTIC FRONTIER

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Iteration 0:   log likelihood = -119.09195
Iteration 1:   log likelihood = -119.09195

Stoc. frontier normal/half-normal model          Number of obs   =        40
                                                 Wald chi2(8)    =     62.29
Log likelihood = -119.09195                      Prob > chi2     =    0.0000
```

u	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
a	-4.853227	2.254073	-2.15	0.031	-9.271129	-.4353252
b	-1.36122	1.154652	-1.18	0.238	-3.624296	.9018566
c	.2286336	1.0457	0.22	0.827	-1.820901	2.278169
d	2.012311	.4527605	4.44	0.000	1.124917	2.899705
e	1.552434	1.013501	1.53	0.126	-.4339921	3.53886
f	8.296268	3.6865	2.25	0.024	1.070862	15.52167
g	2.789236	4.120192	0.68	0.498	-5.286191	10.86466
h	.6020355	.9676638	0.62	0.534	-1.294551	2.498622
_cons	-8.171004	9.507978	-0.86	0.390	-26.8063	10.46429
/lnsig2v	3.116659	.224027	13.91	0.000	2.677574	3.555744
/lnsig2u	-5.486832	204.0595	-0.03	0.979	-405.4361	394.4625
sigma_v	4.750878	.5321624			3.814414	5.91725
sigma_u	.0643502	6.56563			9.13e-89	4.53e+85
sigma2	22.57499	5.07627			12.62568	32.52429
lambda	.0135449	6.618956			-12.95937	12.98646

Likelihood-ratio test of sigma_u=0: chibar2(01) = 0.00   Prob>=chibar2 = 1.000