UNIVERSITY OF CAPE COAST

COMPARATIVE STUDY OF TECHNICAL EFFICIENCY OF PINEAPPLE EXPORTERS AND NON EXPORTERS IN THE CENTRAL REGION OF GHANA

BY

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own work and that no part of it has been presented for another degree in this University or elsewhere.

Candidate's Signature: ---------------------------------- Date:-----------------------

Name: ……………………………………………………………………………

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature: ……………………….. Date: ………………

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ABSTRACT

This study sought to determine and compare the technical efficiency in pineapple production among exporters and non-exporters using primary data collected from four districts of Central Region of Ghana.

Results from the Cobb-Douglass stochastic frontier model and a farm-specific efficiency model showed that for the exporters land and labor had a positive influence on technical efficiency while chemicals and fertilizers, planting materials and annual capital charge had a negative effect. For non-export farmers, land and planting materials and annual capital charge exerted positive effect but chemicals and fertilizers and labour had negative impact on technical efficiency. The analysis also showed that pineapple exporters and non-exporters were not operating on the production frontier and scored a mean technical efficiency of 51 and 55 percent respectively.

Further analysis showed that access to credit is an important factor influencing technical efficiency in pineapple production. Thus efforts aimed at making credit accessible to farmers through the promotion of farmer co-operatives and other miro-credit schemes would be very pertinent in increasing pineapple production for the home and export market.

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DEDICATION

To my parents Mr. Anthony K. Abbam and Madam Rebecca Okyne, my lovely wife and daughter Mrs. Eunice E. L. Abbam and Adwoa Dannyame Abbam.

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LIST OF ACRONYMS

EU	European Union
EUREPGAP	European Good Agricultural Practices
ERP	Economic Recovery Programme
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GhanaGAP	Ghana Good Agricultural Practices
GEPC	Ghana Export Promotion Council
LDC	Less Developed Countries
ISSER	Institute of Statistical, Social and Economic Research
SAPs	Structural Adjustment Programmes
MOFA	Ministry of Food and Agriculture

CHAPTER ONE

INTRODUCTION

Background of the Study

Within the world marketplace, it is estimated that pineapple production and consumption is now at about 13.5 million metric tons per year and the commodity is growing by over 200,000 metric tons annually. The global trade in pineapples totals $1.8 billion annually (FAO, 2004).

The world pineapple market is skewed toward export, with 36 percent of the world's production exported. Processed pineapple products such as juices dominate this market, accounting for 80 percent of the trade. The exports of fresh pineapple are divided between Latin America and Sub-Saharan African exporters and Asian producers (Danielou and Ravry, 2005).

Pineapple business in West Africa keeps on growing. West African countries produce about 10% of the total, or 1.35 million metric tons of pineapples each year. Of this amount, over 210,000 metric tons are exported to an expanding European market (FAO, 2004).

The agricultural sector is very important in the Ghanaian economy due to its immense contribution to the overall development of the economy. This can be measured by its contribution to the key macroeconomic indicators of the economy.

- It contributes between 45%-60% to total GDP
- It employs about 70% of the total active labour force
- It accounts for over 50% of foreign exchange earnings
- The sector is an important source of raw materials for manufacturing
- The agriculturally dependent rural households (80% of the population) form the largest potential domestic market for textiles and other manufactured products by agro-industries (Dapaah, 1994).

Even though there has been an enormous advancement in technology, the traditional crop farming system in Ghana still pertains. This is particularly in the production of food where small-scale farming predominates. This traditional farming system involves the use of locally handmade agricultural tools such as hoes, machetes, and the rest. The prominent agricultural crops forming the base of the economy of Ghana are yam, grains, cocoa, oil palm, kola nut and timber. In Ghana, crop production is for three main purposes; food production for consumption, raw materials for industry, and production for export. The major staple food crops include cereals, mainly rice and maize, and starchy staples, which include yam, cassava and plantain. Industrial raw materials include cotton, oil palm, tobacco and bast fibre.

Ghana like most developing countries in the sub Saharan Africa depends on the export of a few primary commodities and minerals as the main source of government revenue and foreign exchange. The main export commodities include cocoa, gold and timber which are referred to as traditional exports accounts for more than 70% of export earnings. Other non-traditional exports are pineapples, shea nuts, yam, sugar cane, vegetables, fish among others.

Agricultural policies over the past ten years have sought to diversify the export base of the country following the persistent decline in the prices of cocoa and gold in the 1980's and 1990's. Efforts to diversify the export base resulted in the promotion of wood, aluminum, marine products, horticultural products-referred to as non-traditional exports and tourism (ISSER, 2002).

In the past 10 years, Ghana has experienced significant growth in its exports of fruits and vegetables. Between 1980 and 1998, exports earnings from this sub sector grew from US$1.8 million to US$26.8 million. Furthermore, between 1997 and 2004, the total volume of Ghana's exports from this sector more than doubled. Among these goods, pineapple represents the most significant growth commodity, reaching the export number of 70,000 tons roughly US$22 million in 2004. Ghana thus became, along with Côte d'Ivoire and Costa Rica, one of the more important suppliers of pineapple to the European market.

Pineapple ranks first as Ghana's most important non-traditional horticultural export product as it contributes around 24% of total horticultural exports, (ISSER, 2003). The rapid increase in pineapple export has been associated with a series of liberalization policies adopted under the Structural Adjustment Programme (SAP) which included a customs duty drawback scheme, income tax rebate, the gradual removal of foreign exchange controls (Obeng, 1994). In addition, all nontraditional exporters were exempted from export duty.

Ghana presently enjoys a loyal and growing market in the European Union due to compliance with specified standards. The pineapple industry in Ghana is composed of producers and exporters. There are three categories of producers: large, medium and small scale. The large scale producers are those with more than 100 acres of pineapple under active cultivation. Medium scale producers cultivate 50 –100 acres. Small scale producers or outgrowers have less than 50 acres under cultivation. Most of the large scale and some of the medium – scale producers also operate as pineapple exporters (Yeboah, 2005).

Currently, about 2000 hectares of the land in Ghana is cultivated by small, medium and large-scale commercial growers employing mechanized and input technologies. Even though productivity of pineapple is about 50 metric tons per hectare, 80 to 100 is achievable under a very favourable climate condition and good farm management (Food and Agric Sector Development, 2000).

The crop is cultivated mainly in the Eastern, Central and the Greater Accra Regions. The study area – Central Region, which is established in cassava and maize intercropping for sale to the urban consumers has transformed into production of pineapple for both export and local consumption. Apart from being a source of foreign exchange, pineapple production has provided employment and income in the pineapple growing areas. However, the current industry structure and organization in the Central Region makes it very difficult to realize the full potential of the industry, (Food and Agric Sector Development, 2000).

Statement of the Problem

The pineapple industry in Ghana includes farmers who produce for sale in the local market (non exporters) and those who produce purposely for the export market. Although local demand for pineapple is quite high, the fruit commands low price, often not accounting for the costs of production during the peak harvest season. The farmers who produce only for the local market (non exporters) have limited access to mechanical equipment and credit facilities; they buy their own inputs, and sell to any willing buyer. In addition, most of these farmers are vulnerable when it comes to chemical applications. They are the last to receive the right technical information for production and may misapply agrochemicals as they do not have the right technical information nor receive any form of training (Obeng, 1994). Inspite of these constraints these farmers have accepted the challenge to produce in order to satisfy local market conditions and standards.

Those farmers who produce and export however, got a foothold of the European market by targeting the low– end discount segment of the northern European market by relying on an initial air freight cost advantage which was the lowest at the time in the sub-region which enabled them to under price their competitors (Danielou and Ravry, 2005). They were also able to compete by developing efficiencies in the various categories of their cost structure by seeking lower margins, reducing marketing cost, developing more efficient inland logistics and paying lower price at the farm gate as compared to their competitors.

Producing fresh pineapples to satisfy local and stringent European Union markets standards requires non exporters and export producers alike in the pineapple industry to be very efficient in their operations. Despite the handicap of the non export farmers as mentioned earlier, Obeng (1994) has noted that Ghanaian smallholders have a cost advantage over large farms presumably due to the low cost of family labour. She estimates that the production cost per ha for smallholders is 22 percent less than for large farms and furthermore suggests that the yield per hectare on smaller farms is higher than on larger ones.

Truly speaking, with international trade, one may be tempted to assume that producers of fresh pineapple for the external market are technically more efficient in production compared to those who produce for the home market. This stems from the fact that the export producers have to produce pineapples that meet stringent quality and safety standards of their Western consumers. For instance they follow certified farming practices in pineapple cultivation, packaging to suit international standards and export marketing. Nevertheless, it has been reported that in 2001, residue levels of ethephon, used to de-green fruit before harvest, were found on some pineapples from Ghana to exceed European Union (EU) Minimum Residue Levels (MRLs) (Acuonjei, 2008). This therefore raises eyebrows about the efficiency of these exporters in their quest to produce pineapple to meet international certification standards.

From the fore going, one may be tempted to argue that farmers who produce for the local market are more efficient in pineapple production than the exporters. This argument can only be demonstrated by undertaking empirical study of the technical efficiency of pineapple farmers who produce solely for the domestic market and those who produce and export. The issue now is to determine and compare the level of efficiency of pineapple export producers and those who produce for the home market as well as the factors that influence their current levels of efficiency. Identifying the sources of inefficiency will influence policies and programmes designed to monitor and improve performance.

The researcher intends for this study not only to provide insight into the technical efficiency of pineapple export producers and those who produce for the domestic market but also to make others aware of a rich new data sources available for their use.

Objectives of the Study

The general objective of this study is to undertake a comparative study of the technical efficiency of pineapple exporters and non export farmers in the Central Region.

The specific objectives of the study include the following:

i. estimate the production frontier function of pineapple exporters and non exporters.

ii. estimate and compare the technical efficiency of pineapple exporters and the non export farmers in the study area.

iii. assess the effect of institutional factors such as agricultural extension services, access to credit facility and examine the influence of socio-economic factors of the farmers on the technical efficiency of pineapple export producers and non exporters.

Hypotheses of the Study

In the context of the objectives, the hypotheses of the study include:

i. pineapple exporters and non exporters are not operating on the production frontier.

ii. there are no differences in the efficiency of pineapple exporters and non exporters.

iii. factors such as age, education, experience, agricultural extension services, access to credit facility, etc. have no influence on the observed level of technical inefficiency among exporters and non export farmers in Central and Eastern regions of Ghana.

Significance of the Study

i. This study will be of great importance to potential investors, governmental and non-governmental agencies, financial institutions and international agencies supporting the production and export of horticultural products in Ghana.

ii. The donor organizations and aid agencies that are supporting Ghana's agricultural diversification program and also working to improve the livelihood of rural dwellers will gain a lot of insight from this study, especially in the move toward market based development assistance.

iii. The findings of the study will go a long way to create awareness among non exporting pineapple farmers, exporters, policy makers and

Limitations of the Study

It should however, be noted that in production, there are several production processes and techniques and that different farms adopt different production processes and techniques. Therefore a serious limitation to this study is that these processes and techniques with their distinctive features were put in an estimated production function to determine technical efficiency. Again, in this part of our world most firms operate under-capacity and this adversely affect their technical efficiency levels.

Organisation of the Study

The remaining chapters of the thesis are organized as follows: Chapter two presents a detailed discussion on the approaches to efficiency measurement with emphasis on the econometric approach to efficiency measurement. Included in this chapter is a review of empirical studies on technical efficiency in agriculture and pineapple production in Ghana. Chapter three describes the conceptual and analytical framework of the study. In addition, the chapter presents the model specifications and detailed discussion of the variables and data set used in the study. Chapter four details the estimation of farm level technical efficiency and marginal effects. Finally, the conclusions of the major findings and recommendations, and suggestions for further research are discussed in Chapter five.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

The literature review focuses on economic efficiency and its components, the different approaches to measure firm economic efficiency, technical efficiency, managerial slack and studies that have been done on economics of pineapple production, marketing and export in Ghana are discussed.

Economic Efficiency

The analysis of efficiency dates back to Knight (1933), Debrew (1951) and Koopmans (1951). Koopmans (1951) provided a definition of technical efficiency while Debrew (1951) introduced its first measure of the 'coefficient or resource utilization'

Lovell (1993) relates the efficiency of the firm to a comparison between observed and optimal values of its outputs and inputs. If the optimum is defined in terms of production possibilities, the resulting comparison measures technical efficiency. If the optimum is defined in terms of behavioral goals of the firm (e.g., profit or revenue maximization and cost minimization), then efficiency is economic and is measured by comparing a firm's observed and optimum achievement of goals (e.g., profit, revenue, and cost) subject to the appropriate consideration of technology and prices.

Farrell (1957) proposed that the economic efficiency of a firm consists of two components: technical (or physical) efficiency and allocative (or price) efficiency. Technical efficiency is an engineering concept referring to the input-output relationship. It refers to the ability of a firm to produce maximal potential output from a given amount of input or to use a minimal amount of inputs in order to produce a given amount of output. In effect, technical efficiency shows the ability of a firm to produce on the production frontier. Koopmans (1951) provided a formal definition of technical efficiency: a producer is technically efficient if an increase in any output requires a reduction in at least one other output, and if a reduction in any input requires an increase in at least one other input or a reduction in at least one output. Yilma (1996), in his study of efficiency among the smallholder coffee producers in Uganda, defined an efficient farm as that which produces more output from the same measurable inputs than that one which produces less. Fan (1999) referred to technical inefficiency as a state in which actual or observed output from a given input mix is less than the maximum possible.

Price or allocative efficiency represents the ability of a firm to utilize the cost-minimizing input ratios or revenue-maximizing output ratios. Allocative inefficiency occurs if the ratio of marginal physical products of two inputs does not equal the ratio of their prices, e.g., $f_j / f_i \neq w_j / w_i$, where f_i is a marginal physical product of the input x_i, and w_i is the price of the input x_i (Bailey et al., 1989). Thus, a firm is allocatively efficient if it uses the optimal combination of inputs with respect to their prices.

The economic efficiency of the firm is the product of technical and allocative efficiency. Hence, in order to be economically efficient, a firm must be both technically and allocatively efficient. However, this is not always the case as Akinwumi and Djato (1997) pointed out. It is possible for a firm to have either technical or allocative efficiency without having economic efficiency. The reason may be that the farmer, in this case, is unable to make efficient decisions as far as the use of inputs is concerned. In some cases, a farmer might fail to equate marginal input cost to marginal value of product. If technical and allocative efficiency occur together they are both a necessary and a sufficient condition for economic efficiency. This assumes that the farmer has made right decision to minimize costs and maximize profits implying operating on the profit frontier. However, one needs to recognize that in less developed countries (LDCs) there are inherent market failures due to a number of reasons such as government interventions, lack of information on the markets and poor infrastructural development.

If the analyzed industry exhibits variable returns-to-scale, then another component of economic efficiency, scale efficiency, is present. Scale efficiency is used to determine how close an observed firm is to the most productive scale size (Forsund and Hjalmarsson, 1979; Banker and Thrall, 1992). A firm may be scale inefficient if it exceeds the most productive scale size (therefore experiencing decreasing returns-to-scale) or if it is smaller than the most productive scale size (therefore failing to take full advantage of increasing returns-to-scale). Scale inefficiency for a firm is defined with respect to those firms in the sample which operate where average and marginal products are equal (Forsund et al.,1980).

The analyzed industry might also exhibit economies of scope. In this case, scope efficiency exists. Scope efficiency relates to benefits realized by firms that produce several product lines compared to specialized enterprises. This aspect of economic efficiency is of particular interest in agriculture since there are many debates on optimal production structure of agricultural enterprises. An empirical measurement of farms' scope efficiency was proposed by Chavas and Aliber (1993). They measured scope efficiency as the relative cost of producing livestock and crops separately compared to their joint production.

Approaches to Efficiency Measurement

Empirical analysis in production economics has been dominated by estimators derived under symmetric error assumptions, rather than enveloping the data, as would be appropriate for a production or profit function, or the cost function (Coelli, 1995). Assuming a central tendency in observed firms, the estimated functions represent the shape of technology of an average firm (Lovell, 1993). Conversely, the frontier approach, which has become increasingly popular over the last ten years, provides a measure of technology represented by the best-performing firms of the industry. The performance of all firms is compared against a constructed frontier, which enables the analyst to evaluate each firm's behavior (Charnes et al., 1997).

A frontier function represents a best-practice technology, against which the efficiency of the firms within the industry can be measured (Coelli, 1995). If a firm belongs to the frontier, it is efficient. If a firm is beneath the efficiency frontier, then it is technically inefficient and further analysis identifies the sources and extent of the inefficiency.

There are two primary frontier approaches to the measurement of efficiency: parametric, which involves econometric methods, and nonparametric, which employs mathematical programming. The parametric approach relies on a parametric specification of the production function, cost function, or profit function fitted to the data (e.g., Forsund et al., 1980; Bauer, 1990a). Parametric specification of the production function is mostly performed by employment of stochastic frontier analysis (SFA), which accounts for both inefficiency and random noise effects. Given the fact that production processes in agriculture are stochastic, the choice of SFA for efficiency measurement seems obvious. However, an important weakness of the SFA is that parametric restrictions on the production technology can confound the efficiency results (Lovell, 1993; Reinhard et al., 1999; Bauer, 1990b).

The non-parametric Data Envelopment Analysis (DEA) approach for measuring efficiency was introduced in 1978 by Charnes, Cooper, and Rhodes. They used mathematical programming to generalize Farrell's (1957) single-output/single-input technical efficiency measure by transforming a multiple-output/multiple-input technology into one combined output and one combined input. This technique has become an accepted management science tool in performing efficiency analysis. Charnes et al. (1978) described the DEA methodology as a mathematical programming model applied to the observed data (which) provides a new way of obtaining empirical estimates of extreme relations such as the production functions and/or efficiency production possibility surfaces that are the cornerstones of modern economics. The increasing popularity of this approach is endorsed by the fact that between 1978 and 1992, over 400 articles, books, and dissertations involving DEA were published (Charnes et al., 1997).

Contrary to econometric approaches, programming approaches avoid the problem of misspecification of functional form (of both technology and inefficiency). Also, programming approaches can easily handle disaggregated inputs and multiple output technologies (Charnes et al., 1997). However, being non-stochastic, the DEA approach does not distinguish data noise and inefficiency (Lovell, 1993; Coelli, 1995). It should be noted here that stochastic DEA models, which eliminate such problems, have been developed in the literature (e.g., Land et al., 1990; Desai and Schinnar, 1987; Sengupta, 1987; Petersen and Olesen, 1989).

However, empirical implications of these models are extremely difficult due to rigorous data requirements. In addition to the inputs and outputs data, it is necessary to have information on expected values of all variables, variance-covariance matrices for all variables, and probability levels at which feasibility constraints are to be satisfied (Lovell, 1993).

Another problem that might occur with use of DEA models refers to the dimensionality of the input/output space relative to the number of observations in the cross section. The dimensionality problem arises when the number of observations is relatively small compared with the number of inputs and outputs used (Suhariyanto, 2000). A negative consequence of this problem is that many of the analyzed DMUs will be rated as "efficient" and therefore lie on the production frontier (Leibenstein and Maital, 1992).

There are different opinions about the ratio between the number of observations and number of inputs and outputs that will enable the DEA model to discriminate efficient firms from inefficient. Charnes and Cooper (1990) stated that ratio should equal at least three, while Fernandez-Cornejo (1994) argued that it should exceed five. Smith (1997), after conducting a simulation study, found that even in cases when the number of observations exceeded the number of factors by more than thirteen times, DEA still can overestimate true efficiency by 27 percent.

The Econometric Approach to Efficiency Measurement

Econometric models can be categorized according to the type of data employed; i.e., cross-sectional or panel data. Assume that a cross-sectional data on the quantities of K inputs used to produce a single output are available for each of N producers. A production frontier model can be written as

$$Y, =f(X_i; \beta). TE, \qquad (3.1.1)$$

where y, is the scalar output of producer i, i=1, ----, N, x_i is a vector of K inputs used by producer i, $f(X_i ; \beta)$ is the production frontier, β is a vector of technology meters too be estimated, and TE is the output-oriented technical efficiency of producer i.

In the econometric models of efficiency measurement, production frontiers are characterized by smooth, continuous, differentiable, quasi-concave production transformation functions. The frontier is the limit to the range of possible productions. Hence, we have

$$TE_i = \frac{Y_i}{f(X_i ; \beta)} \tag{3.1.2}$$

which defines technical efficiency as the ratio of observed output to maximum output feasible under the current technology used. Y_i achieves its maximum value of $f(X_i ; \beta)$ if, and only if, $TE_i = 1$. The amount by which an observation lies below the frontier is called inefficiency when $TE_i < 1$.

An econometric model can be classified as either deterministic frontier model or stochastic frontier model based upon the assumptions about the statistical noise and the way that inefficiency is defined. In equation (3.1.1) the production frontier $f(X_i; \beta)$ is deterministic. In equation (3.1.2) the entire shortfall of observed output y, from maximum feasible output $f(X_i;\beta)$ is attributed to technical inefficiency. The deterministic frontier would take factors outside the control of the unit, such as bad weather, uncertainties in the market situation and so on as inefficiency. Any error or imperfection in the specification of the model could likewise translate into increased inefficiency measures. A more realistic interpretation is that any particular producer faces their own production frontier, and that frontier is randomly placed by the whole collection of stochastic elements that might enter the model outside the control of the producer. The stochastic production frontier incorporates producer-specific random shocks into the analysis. This is accomplished as

$$Y_i = f(X_i;\beta).\exp\{v_i\}.TE_i. \tag{3.1.3}$$

where $[f(X,;\beta).\exp\{v,\}]$ is the stochastic production frontier. With this specification equation (3.1.2) becomes

$$TE_i = \frac{Y_i}{f(X_i;\beta).\exp\{v_i\}}, \qquad (3.1.4)$$

defining technical efficiency as the ratio of observed output to maximum feasible output in an environment characterized by exp {v,}. In this case y, achieves its maximum value of $[f(X_i;B).\exp\{v,\}]$ if, and only if, TE,=1. Otherwise TE, <1 provides measure of the shortfall of observed output from maximum feasible output in an environment characterized by stochastic elements that varies across producers.

Either deterministic frontier model or the stochastic production frontier model can be used to estimate technical efficiency. The development of econometric methodology has two distinct stages. In the early application, attempts made to force the model specification to conform to the underlying theory. In current terminology, these specifications have been denoted "deterministic" frontiers. The second stage brought a more flexible approach to the specification of the frontier model, the "stochastic frontier" model. For further details, the reader is referred, for example, to one of the many surveys on the subject, such as Kumbhakar and Lovell (2000).

Review of Technical Efficiency Studies in Agriculture

Kalirajan and Flinn (1983) estimated the technical efficiency of 79 rice growers in the Philipines to get the maximum likelihood parameters. They used a

Translog stochastic frontier production function. The technical efficiency was regressed on factors such as fertilizer application, farming experience extension service and transplanting of rice seedlings. These factors were found to significantly influence variables on technical efficiency, which averaged 50 percent in this study.

Yao and Liu (1988) used stochastic frontier production function in studying grain (rice, wheat and maize) production in Chin. Inputs included land, labour, fertilizer, machinery and irrigation. Land with an elasticity of 0.95, turned out to be most important factor of production. The average efficiency score was 36 percent. Labour led to low efficiency. They concluded that improved technology, better irrigation and pesticides could improve productivity.

Dawson and Lingard (1989) used a Cobb-Douglas stochastic frontier production function in estimating the technical efficiency of Philipino rice growers for a period of four years. The mean technical efficiency was 65 percent, ranging from 10 to 99 percent. They found that 70 percent of farmers were technically efficient in 1982 as compared to remaining three years. They suggested that to improve efficiency, farming experience and contact with extension service were helpful.

Kalirajan (1989) estimated technical efficiencies of individual farmers engaged in rice production in two regions in the Philippines in 1984-85. A Cobb Douglas stochastic frontier model was found to be more appropriate. The predicted technical efficiencies were regressed on several farm and farmer-specific variables to determine the extent of effects of variables in the variation of technical efficiencies.

Bailey, et al. (1989) used a stochastic frontier production to estimated technical, allocative and scale efficiencies for cross-sectional data on 68 Ecuadorian dairy farms. The technical efficiencies if individual farms were about 88 percent. However, little variation in technical efficiency was found among individual farms.

Seyoum, Battese and Fleming (1998) used Cobb Douglas stochastic frontier in estimating technical efficiency and productivity of maize producers in Ethiopia. Cross-sectional data for 1995-1996 was used. Results showed that the project farmers had higher technical efficiencies and productivity that those of the non-project counter parts. The mean technical efficiency of the former was 97 percent while those of the latter were 79 percent. Small growers within the project were even still better. The study suggested that adoption of new technologies could materially improve output and income of the farmers.

Battese and Hassan (1999) analysed data of cotton farmers using a stochastic frontier function model in which technical inefficiency effects are assumed to be a function of other observable variables related to the farming operations. Although most cotton farmers have high technical efficiency of production in the Vehari district, there is a significant proportion of the sample farmers who have much lower levels of technical efficiency. Technical inefficiency of cotton production tended to decrease for farmers who first irrigated their crops later and who performed rogging, but inefficiencies tended to increase with more interculture operations.

Umoh (2006) employed the stochastic frontier production function to analyse the resource use efficiency of urban farmers in Uyo, Southeastern Nigeria. The result showed that 65% of urban farmers were 70% technology efficient; maximum efficiency is 0.91, while minimum efficiency in urban farm is 0.43.

Obwona (2006) adopted the stochastic frontier production approach to study the determinants of technical efficiency differentials amongst 65 small and medium scale tobacco farmers in Uganda. The study showed that education, credit accessibility and extension services contributed positively towards the improvement of efficiency. Therefore if more resources are invested in extension services, the availability of credit is improved and there is less fragmentation of land, then there will be improvement in technical efficiency levels of tobacco farmers in Uganda.

Shehu and Mshelia (2007) investigated the productivity and technically efficiency of small-scale farmers in Adamawa State, Nigeria using stochastic frontier production function. The empirical results indicate that the farmers were operating in the irrational stage of production (stage I) as depicted by the returns to scale of 1.06. The predicted technical efficiencies for the farmers ranged from 74% to 98.9% with a mean of 95.7%. Improvement on farmers' educational levels through adult education and literacy campaign as well as regulating household size by advocating the need for family planning would probably lead to improvement in technical efficiency in the long term.

Nchare (2007) studied the factors affecting the technical efficiency of Arabica coffee producers in Cameroon using the translog stochastic production frontier function. The mean technical efficiency index of the 140 farmers during the 2004 crop year was estimated to be 0.896. It was found that the educational level of the farmer and access to credit were the major socioeconomic variables that influenced farmer's technical efficiency.

Ajao, et al. (2008) analysed the technical efficiency of poultry egg producers in Oyo State of Nigeria using a Cobb-Douglas stochastic production frontier function. They showed that the technical efficiency of farmers varied between 0.10 and 0.99 with mean of 0823. They found that stock of birds is the most important determinant of poultry egg production while years of experience, management system, educational level and family size are the socioeconomic characteristics influencing the farmer's technical efficiency.

Baten et al. (2009) applied Cobb-Douglas Stochastic frontiers in which the technical inefficiency effects are defined by a model with two distributional assumption. The results show that technical inefficiency has declined over the reference period and the truncated (at zero) normal distribution is preferable to the half normal distribution for the technical inefficiency effects.

Tijani (2009). The study which investigates the effect of micro-credit on technical efficiency in food crops production, involving the use of maximum likelihood estimation technique of stochastic production frontier, shows the returns to scale value of non-credit user's farmers (1.30) being greater than that of credit user's farmers (0.40). The mean technical efficiency for the two groups of farmers is between 0.5 (for credit user's farmers) and 0.9 (for non-credit user's farmers). He therefore concluded that to improve the technical efficiency of rural food crops farmers in Nigeria aims at increasing their production, policies design should emphasise more rural financial outlets to the financial institutions, whose lending should be timely and in larger amounts without discriminating against small farm holdings farmers.

In their study of aquaculture farms in the Southern Sector of Ghana, Onumah and DeGraft (2010) found that these farms are characterised by technology with increasing return to scale. Again, they found that the combined effects of operational and farm specific factors influence efficiency. Comparison of technical efficiency according to regions did not show any significant variation. The study overall mean technical efficiency to be nearly 80.8%.

Kumbhakar et al. (1991) investigated the determinants of technical and allocative in inefficiency in US dairy farms. The stochastic frontier approach was used involving a single-step maximum likelihood procedure. They found that the levels of education of the farmer are important factors determining technical inefficiency. Besides, the large farms are more efficient (technically) than small and medium-sized farms. The conclusion was that both technical and allocative inefficiencies decrease with an increase in the level of education of the farmer.

However, Kalirajan and Shand (1985) argue that although schooling is a productive factor, farmer's education is not necessarily related significantly to their yield achievement. Illiterate farmers, without the training to read and write, can understand a modern production technology as well as their educated counterparts, provided the technology is communicated properly.

Review on Leibenstein's Technical Inefficiency (X- inefficiency) and Managerial Slack

Leibenstein (1966) included Pakistan in his article on inefficiency. He reported that there 'sample technical alteration', 'payment by result', 'workers training and supervision' in textile factories significantly increased productivity and reduced unit cost. Improvement in productivity ranged from 10 percent to 141 percent, unit cost was also reduced by similar range.

Shepherd (1972b) used industry data for 336 industry for the period 1963 – 1967. Again, he showed that profit margins and market share and firm size are positively related, except for the older group. He concluded that these results are due at least in part to increasing X-efficiency accompanying increasing size and power.

Bergsman (1974) estimated both allocative and X-inefficiency as a percent of GNP as a results of protection from foreign competition for Brazil, Malaysia, Mexico, Norway, Pakistan, and the Philippines. His estimates of the cost of protection (as percentage of gross national product) in terms of allocative inefficiency for the six countries listed above are 0.3%, -1.2%, 0.3%, -0.2%, 0.5% and 1.0%, respectively. On the other hand, the cost in terms of X-inefficiency (plus monopoly returns) are 6.8%, 0.4%, 2.2%, 0.2%, 5.4% and 2.6%, respectively. A comparison of two types of economies – small, relatively open economies, and small, heavily protected economies – yields expected results. The average level of allocative inefficiency in the open and protected economies are -0.07%, and 0.75%, respectively. The average level of X-inefficiency in each group is 1.2%, and 4.0% respectively. The results that X-inefficiency is larger than allocative inefficiency, and the results are larger for protected economies is consistent with X-efficiency theory.

Shapiro and Muller (1977) estimated the relationship between X-inefficiency and modernisation among a group Tanzania famers. Applying a production function including only labour and land as independent variables showed that the frontier firms achieve greater X-efficiency through higher labour productivity but not through higher capital productivity. Labour productivity gains were achieved through the 'modernisation ethic' – a willingness to be efficient – not merely through the efficient use of existence of knowledge.

Silkman and Young (1982) studies costs of providing local school transportation among 1317 school districts and local library services for 749 local public libraries. The other-people's-money effect predicts that the incentive for local government to be cost X-efficient will be reduced. They reported that when the local share for school transportation increases by 10%, the per-capita deviation from the cost frontier falls by 2.8%. For local libraries the figure is 3.4%. An average school district with a population of 20,000 would find an operating cost savings of approximately 4.5% when the local share of revenues increased by 10%.

Stevenson (1982) examined the costs of generating electricity among a sample of 79 US utilities, 25 combination utilities and 54 straight combination utilities for 1970 and 1972. Using 1970 data, Stevenson reports that the sample mean the average costs of generation electricity was 6.1% lower for straight utilities that for combination utilities. Using 1972 data the average costs for straights was 8.5% less than that for combinations. The X-efficiency effect exceeds the economies of scope. In addition, over the period 1964-1972, straight utilities reduced their costs faster than did the combination utilities.

In his study of the hospital industry, Meyer (1982) found that managerial slack served as an organizational shock absorber, cushioning the impact of regulatory change. Also, slack is a buffering mechanism to protect the firm from internal fluctuations.

Craven, Dick and Wood (1986) investigated how changes in funding for non-University education in Britain affected X-efficiency in one English polytechnic for the years 1979 – 84. The number of full-time equivalent (FTE) students increased, FTE expenditures fell, academic staff fell while nonacademic staff increased by 9%. The quality of education-measured by the percentage of students passing their exams, the number of students graduating with honours, and faculty publications – did not fall; and, the cost per students fell. They interpreted these results as an increase in X-efficiency motivated by a reduction in resources.

Scharfstein (1988) analyzed the effect of product-market competition on managerial incentives. He showed that competition may actually exacerbate the incentive problem. The difference in results derives from our different assumptions about managerial preferences. The importance of assumptions about preferences suggests that we do not yet understand the precise mechanism through which competition affects incentives.

Register and Grimes (1991) studied shock effects of unions on the educational performance of 2360 secondary database. Empirical results show that a unionised faculty, ceteris paribus, increases the SAT score on the college entrance exam by almost 5%. The authors explanation is that given tight budget, a union create a shock effect, forcing school administrators to increase X-efficiency as a way of controlling their budgets.

In his study of 288 US firms from 1976 to 1987 using the IV estimation, Bromiley (1991) observed that available slack leads to increases in a firm's performance while recoverable slack impacted negatively on performance.

Leibenstein and Maital (1992) studied 19 Boston National Hockey League players who played at least 30 games during the 1989 – 1990 season using the Data Envelopment Analysis (DEA) found that 4 out of 19 players are X-efficient, that is maximising goals and assists for a given salary and shots on goals. Not, surprisingly, the forwards (0.747) had a higher X-efficiency score that the defense-oriented players (0.464). The four completely X-efficient players were all forwards while the lowest X-efficient scores -0.271 and 0.158 were both for defense oriented players.

Majumdar (1993a) investigated X-efficiency among 40 local operating companies of the telecommunications industry between 1973 and 1987, 22 ATT firms and 18 independents. Using DEA, average x-efficiency scores for the former ATT firms was 0.504 in 1973, 0.827 in 1984, and 0.882 in 1984. The percentage of firms at the frontier increased from 5% (1973) to 40% (1987).

Nohria and Gulati (1996) argued that slack provides organizations with the ability to be proactive as well as defensive in adopting new technologies or designing new lines of services. However, in testing this hypothesis, they found a curvilinear relationship between slack and performance, that is, innovation was hurt under conditions of low and high slack but helped when slack was in the intermediate range. One explanation for such a phenomenon is that too much slack may inhibit organizational strategic adaptation because it lessens responsiveness to environmental change.

Schmidt (1997) showed that the influence of competition on managerial incentives is ambiguous, since competition lowers the probability of liquidation for firms with managerial slack, while it also reduces the firm's profits.

Majumdar (1998) adopted the Data Envelopment Analysis to study slack in state owned enterprises in India. He contended that organizational slack is simply inefficiency, which hurts firm performance. He showed that performance of state owned firms tends to be lower than that of private firms and foreign firm. This is because state-owned firms have soft budget constraint which depicts looseness of resource utilization resulting from expectation of additional subsidies from the state. This looseness generates inefficiency which in turn causes organizational slack.

Arya (2000) established that the choice of an information system affects the level of managerial slack that is generated during project implementation. Whether slack is beneficial or costly to an organization has been the subject of debate. In our model of the hold-up problem in capital budgeting, there are both costs and benefits to having managerial slack. The cost of slack is the consumption of perquisites by the manager. The benefit of slack is that it can serve as a motivational tool. The possibility of increasing his slack may encourage a self-interested manager to conduct a more diligent search for a profitable project.

Tan (2002) determined the curvilinear relationship between organizational slack and firm performance among 17,000 Chinese state firms using the OLS showed that the effect of organizational slack on firm performance is inverse U-shaped which means that as organizational slack increases firm performance increases at first and then decreases after exceeding a certain point.

Mizutani and Nakamura (2009) applied 3SLS simultaneously using the data sets of about 2000 Japanese firms from the years 2001 to 2006 to empirically study Japanese firm's behavior found that a firm's performance declines as organizational slack increases; organizational slack decreases as managerial incentive is strengthened and a firm's annual change rate of revenues increases. They further showed that managerial incentive is affected by corporate governance structure but not by performance.

Avellaneda, et al. (2010) used an unbalanced panel covering 582 Colombian municipalities from 2005-2008 to test the rentier hypothesis in

Colombian local governments. After controlling for a host of alternative explanations, they found that increases in natural resource royalties are indeed positively associated with organizational slack but that managerial quality does not discernibly moderate this relationship.

In their study of competition, quality and managerial slack, Golan, et al, (2010) showed that, if competition increases the probability of failure, managerial slack increases with competition. They reconciled their result with contrary empirical findings by pointing out that what has been empirically tested is changes in slack in response to exogenous changes in the disutility of effort.

Giroud and Mueller (2010) considered the effect of business competition laws on industries of varying degrees of competition, which they measure by sales distributions (Herfindahl- Hirschman Index). They found that in competitive industries there were little or no changes in measures of value, while there were drops in value for the least competitive industries. They further established that while the opportunity for managerial slack increases equally across all industries, managerial slack appears to increase only in non-competitive industries, but not in highly competitive industries, where competitive pressure enforces discipline on management.

Review of literature show that all the studies were conducted on major agricultural enterprises including rice, tobacco, cotton, poultry eggs, etc. From the above studies it can be realized that the frontier approach has been used to measure efficiency of the agricultural sector. However, according to our knowledge no study was found on technical efficiency in pineapple production in

Ghana. The studies reviewed revealed that technical inefficiency (X-inefficiency) was a major problem, the causes of which included poor managerial qualities of the producers. Agricultural productivity could be enhanced by improving managerial qualities (technical skills and knowledge) of the farmers or firms (Ali and Flinn, 1989).

Previous Studies on Pineapple in Ghana

Yeboah (2005) studied the economics of pineapple production and marketing in Ghana. His first study, Farmapine Model: A comparative marketing strategy and market based development approach and profitability and risk analysis, the case study of Ghana's pineapple exports. This study has policy implications especially in terms of poverty alleviation and sustainable development. His study supports Ghana's efforts to diversify its export base and overall economy from over dependence on gold and cocoa which has contributed more than 80% of foreign exchange.

The Farmapine Model examined the cooperative marketing arrangement between small-scale producers also known as small holders and exporters. It also examined the institutional arrangement behind the establishment of Farmapine, the risk structures in this arrangement and how the model deals with them and the inherent efficiencies in the Farmapine model over existing arrangements. Besides, the model examined the feasibility of replicating the model in other farming communities in Ghana and explored the possibility of extending it to other developing countries.

In his second study –profitability and risk analysis: The case of Ghana's pineapple exports, Yeboah (2003) analysed the profitability of pineapple production and export and how profitability is impacted by risk using the quadratic programming. The main objectives of the study were to discuss the problems associated with pineapple production and marketing.

Udry and Conley (2004) examined the social networks among farmers in a developing country. They explored the determinants of these important economic networks by describing patterns of information, capital, labour and land transaction.

Tsutomu (2004), in his study of smallholders and non-traditional exports under economic liberalization-the case of pineapples in Ghana, examined the characteristics of three categories of pineapple producers for export – smallholders, nonresident commercial farmers, and large-scale producers-exporters. According to him, the smallholders offered exporters little advantage over large plantations and were marginalized. A donor-supported new export company was also examined and interpreted as an institutional solution to overcome the disadvantages faced by the smallholders.

Danielou and Ravry (2005) in their study-The rise of Ghana's pineapple industry: From successful takeoff to sustainable expansion, analyzed the strategies Ghana has adopted to develop its horticulture sector, gain greater market access, and become a leader in global markets. It presents the protagonists and their respective roles and focuses on the production and marketing innovations that were adopted at different moments to remain competitive and adapt to the new market context. Finally, it proposes lessons to be learned from Ghana's initial success and suggests new challenges the country will have to face to maintain its performance and position.

In his study - the expansion of a pineapple plantation in Ghana, Sesay (2006) examined the feasibility of the expansion drive by the Princess Cold Stores Limited of its pineapple plantation to include the possibility of exporting a substantial percentage of the produce to the European market. An assessment on the project viability is taken from the perspectives of different stakeholders and the results show that the incremental benefits to derive from undertaking the project exceeds its related incremental costs. This excess benefit, therefore, translates the project feasibility to its respective stakeholders and as such was found viable and also having the capacity to contribute immensely to the financial net cash flow and economic benefit of the project and to the economy at large.

Pineapples are generally seen as a plantation crop suitable for mechanisation and industrialised organisation of production (Jaffee 1994, 1995). The pineapple industry in Central region is made up of smallholders who produce both for local consumption and export and large scale farmers with vertical integration production systems whose main focus is the export market.

CHAPTER THREE

METHODOLOGY

Introduction

In this chapter the general stochastic frontier production function, which will be used to estimate the technical efficiency of both pineapple exporters and non exporters in Central Region will be developed. This begins with development of a framework to measure technical efficiency based on the production function framework. The chapter lays down the methodological assumptions and the framework of the stochastic frontier model that is estimated. This section therefore, concludes with a brief description of the study design and the variables used in the study.

Conceptual Framework

The level of technical efficiency of a particular firm is characterised by the relationship between observed production and some ideal or potential production (Green, 1993). If a firm's actual production point lies on the frontier it is perfectly efficient. If it lies below the frontier then it is technically inefficient. The concept of technical efficiency is based on input and output relationships. Technical inefficiency arises when actual or observed output from a given input mix is less than the maximum possible. In order for the firm to maximise profit, it has to produce the maximum output given the level of inputs employed (i.e. be technical efficient). Technical efficiency can be illustrated graphically using a simple example of a two input (X_1, X_2)-two output (Y_1, Y_2) production process as shown in the figure below.

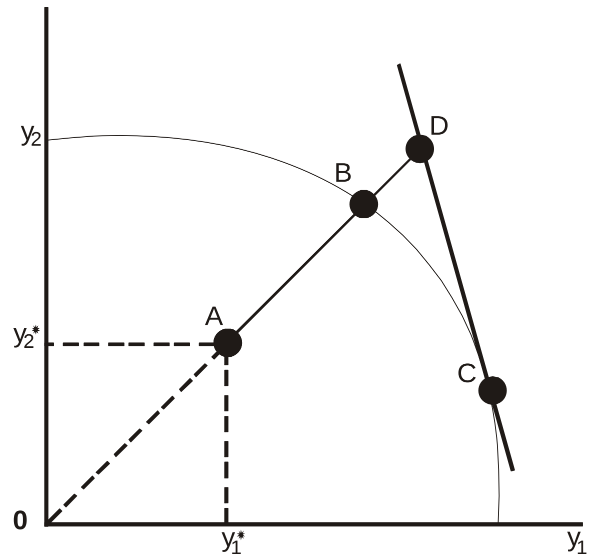

Figure 1: Output Oriented Efficiency Measures

Source: (Ines, H. and Sean, P., 2002)

From the figure above, if the inputs employed by the firm were used efficiently, the output of the firm, producing at point A, can be expanded radially to point B. Hence, the output oriented measure of technical efficiency [TEo (Y,X)], can be given by OA/OB. This is only equivalent to the input-oriented measure of technical efficiency under conditions of constant returns to scale. While point B is technically efficient, in the sense that it lies on the production possibility frontier, a higher revenue could be achieved by producing at point C (the point where the marginal rate of transformation is equal to the price ratio (P_2/P_1). In this case, more of y_1 should be produced and less of y_2 in order to maximise revenue (Kumbhaker and Lovell, 2000).

Assumptions

There are several assumptions that underlie the present study. Firstly, it assumed that both pineapple producer exporters and non export farmers have identical production functions respectively.

The second assumption is that the non export farmers use identical factors of production. Thirdly, the producer-exporters also use the same factor inputs in producing pineapples for the export market.

Besides, the study assumes that all the production inputs and socio-economic characteristics are included in the specification of the stochastic frontier model.

Finally, the composed error term (e_i=u+v) is symmetric independently distributed as $N(0, \sigma^2_v)$ random variables independent of u.

Analytical Framework

The stochastic frontier model or production function in efficiency studies is used in this study to estimate the technical efficiency of non-export pineapple farmers and pineapple exporters in the Central Region.

Econometricians have estimated average production function for a very long time. However, with the pioneering but independent work of Farrell (1957), serious considerations have been given to the possibility of estimating the so-called frontier production functions in an effort to bridge the gap between theory and empirical work (Aigner, Lovell and Schmidt, 1977).

The modelling, estimation and application of stochastic frontier production functions to economic analysis assumed prominence in econometrics and applied economics analysis during the past two decades (Ojo, 2003). Battase and Corra (1977) applied this technique to the pastoral zone of Eastern Australia. In recent times, empirical applications of the technique in efficiency analysis have been reported by Ajibefun and Abdulkadri (1991); Ojo and Ajibefun (2000).

The idea of stochastic frontier can be illustrated with a firm using m inputs (Xa_1, Xa_2, Xa_3, ….Xa_m) to produce output Y. Efficient transformation of inputs into output is characterised by the production function f (X_i) which shows the maximum output obtainable from various input vectors. The stochastic frontier production function was independently proposed by Aigner et al (1977) and Meeusen and van den Broeck (1977).

Assuming the presence of technical inefficiency in production, a stochastic frontier model is specified as:

$$Y_i = f(X_i;\beta) + \varepsilon_i, \quad i = 1, 2, \ldots N \qquad (4.4.1)$$

$$\varepsilon_i = V_i + U_i \qquad (4.4.2)$$

Where Y_i represents the output level of the i^{th} sample farm; $f(X_i;\beta)$ is a suitable function such as Cobb-Douglas or translog functions of vector x_i of inputs for the i^{th} farm and a vector β of unknown parameters. The term e_i is an error term made up of two components: V_i and U_i. The term v_i is a random error having zero mean $N(O, \sigma^2_v)$, which is associated with random factors such as measurement errors in production, weather and disease outbreak which is beyond the control of the pineapple farmer. It is assumed to be symmetric independently distribution as $N(O, \sigma^2_v)$ random variables and independent of U_i. The term U_i on the other hand is a non-negative truncated half normal, $N(O, \sigma^2_u)$ random variable associated with farm-specific factors which leads to the i^{th} farm not attaining maximum efficiency of production. Thus u_i is associated with technical inefficiency of the farm and it lies between zero and one. Also, U_i could be half normal at zero mean and based on conditional exponential (-U). The current study assumes the u_i to follow half normal distribution.

In the model, the stochastic frontier distinguishes between the observed output Y_i and the frontier output Y_j*

Following from the above;

observed output $(Y_j) = X_i\beta + V_i - U_{i,}$ and (4.4.3)

frontier output $(Y_j^*) = X_i\beta + V_i$, $U_i = 0$. (4.4.4)

Hence for the i^{th} farm, given its inputs, the technical efficiency of an individual farm is defined as the ratio of the observed output and the frontier output, given the level technology. This is specified as;

$TE_j = Y_i / Y_j^*$ (4.4.5)

Following from the above equation, technical efficiency (TE_j) can be re-written as: $TE_j = X_i\beta + V_i - U_{i,} / X_i\beta + V_i$, (4.4.6)

Hence $TE_j = \exp(-U)$ (4.4.7)

Measuring the level of technical inefficiency of farm j requires estimating the disturbance term U_i, which allows for a number of farms to operate at full capacity. It reflects the fact that each farm's production must lie on or below the frontier. The value of technical efficiency lies between zero (0) and one (1). A farm is said to be technically efficient if its output level is on the frontier that is Y_j/ Y_j^* equals one. A value of one (1) shows that the i^{th} farm displays complete technical efficiency. However, a technical efficiency value close to zero indicates the degree of inefficiency of the farm. Technically efficient farms are those that operate on the production frontier and the level by which a farm lies below its production frontier is regarded as a measure of technical inefficiency.

According to Bravo-Ureta and Pinheiro (1993), if no explicit distribution for the efficiency component is made then the production function could be estimated using the corrected ordinary least squares (COLS) version. However, if an explicit distribution is assumed, such as exponential, half normal or gamma distribution, then the frontier is estimated by maximum likelihood estimates (MLE).

Assuming a half- normal distribution of u, the mean technical efficiency is measured by $E[\exp(-u_j)]=2[\exp((-\gamma\sigma^2/2))][1-F(\sigma\sqrt{\gamma})]$ (4.4.8)

Where, F is the standard normal distribution function. Measurement of farm-level inefficiency requires the estimation of non-negative error, U. Given the assumptions of the distribution of V and U, Jondrow et al. (1982) first derived the conditional mean of U given ε. Battese and Coelli (1988) derived the best predictor of the technical efficiency of a farm i, $TE_i = \exp(-U_i)$ as

$$E[\exp(-u_j)|\varepsilon]= \left(\frac{1\text{- }F(\sigma_A + \gamma\varepsilon_i/\sigma_A}{1\text{- }F(\gamma\varepsilon_i/\sigma_A)}\right)\exp(\gamma\varepsilon_i+\sigma_A^2/2) \quad (4.4.9)$$

Where $\sigma_A = \sqrt{\gamma(1 - \gamma)\sigma^2}$. The maximum-likelihood estimates (MLE) of the parameters of the model defined by (4.4.1) and the farm-specific TE defined by (4.4.6) are obtained using Limdep software programme. The variance parameters (σ^2_u and σ^2_v) are expressed as follows: $\sigma^2 = \sigma^2_v + \sigma^2_u$ and $= \sigma^2_u / \sigma^2_v$.

The value of λ ranges from 0 to 1, with value equal to 1 indicating that all the deviations from the frontier are due to technical inefficiency (Coelli et al, 1998).

The maximum likelihood estimates method was adopted in this study because it makes use of the specific distribution of the disturbance term and this is more efficient than the corrected ordinary least squares version.

Empirical Frontier Models

There exist a number of functional forms in literature for estimating the production function. This includes the Cobb-Douglas, translog, quadratic and transcendental production functions. The Cobb-Douglas functional form is simple, popular and is frequently used to estimate farm efficiency despite its known weaknesses (Dawson and Lingard, 1991; Kalirajan and Obwona, 1994). However, it imposes a severe prior restriction on the farm's technology by restricting the production elasticities to be constant and the elasticities of input substitution to unity (Wilson et al, 1998). The translog functional form is more flexible in permitting substitution effects among inputs and is said to be relatively dependable approximation to reality (Giulkey, Lovell, and Sickles, 1983). Some of the weaknesses of the translog model are its susceptibility to multicollinearity and potential problems of insufficient degrees of freedom due to the presence of interaction terms. The interaction terms of the translog also do not have economic meaning (Abdulai and Huffman, 2000).

In this study, the Cobb-Douglas frontier model is estimated for analysis notwithstanding its well-known limitations (Bravo-Ureta and Pinheiro, 1993; Battase and Hassan, 1999; Hassan, 2004) since it is not difficult to estimate and manipulate mathematically. Besides, Kopp and Smith (1980) have indicated that functional form has a distinct but rather very small impact on estimated efficiency. Since factor inputs used by pineapple exporters are different from that of the non exporters separate models would be estimated for the two categories of farmers. The specific models estimated are given by:

$$\ln Q_{exp} = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + V_j - U_j \qquad (4.5.1)$$

where ln denotes logarithm to base 'e' and the subscript 'exp' in the model indicates that it applies to pineapple exporters.

Q= the maximum attainable output for a given level of all inputs and is measured in tons.

X_1= total land area cultivated, measured in acres.

X_2= total amount of labour used measured in man-days.

X_3= quantity of fertilizer and chemicals used, measured in kilograms.

X_4= quantity of planting materials used, measured in kilograms.

X_5= annual capital charge measured in Ghana cedis (GH¢).

$$\ln Q_{nex} = \beta_0 + \beta_1 \ln W_1 + \beta_2 \ln W_2 + \beta_3 \ln W_3 + \beta_4 \ln W_4 + \beta_5 \ln W_5 + V_i - U_i \qquad (4.5.2)$$

where ln denotes logarithm to base 'e' and the subscript 'nex' in the second model indicates that it applies to non exporters.

Q = the maximum attainable output for a given level of all inputs and is measured in tons.

W_1 = total land area cultivated, measured in acres

W_2 = the total amount of labour used in man-days.

W_3 = quantity of fertilizer and chemicals used measured in kilograms.

W_4 = quantity of planting materials (suckers and plantlets) used measured in kilograms.

W_5 = annual capital charge measured in Ghana cedis (GH¢).

In this study, both pineapple exporters and non exporters are treated as homogeneous. Thus all inputs and outputs in the production processes of these farmers are of the same nature. The models (4.5.3) and (4.5.4) are used to study determinants of their technical efficiency levels. They are specified as follows:

$$TE_{exp} = \Omega_0 + \Omega_1 Ag + \Omega_2 Ex + \Omega_3 Ae + \Omega_4 Ed + \Omega_5 Ac + \varepsilon_t \qquad (4.5.3)$$

where subscript 'exp' in (1) above shows that it applies to pineapple producer-exporters.

Ag = age of the export farmer expressed in years.

Ex = experience of the export farmer expressed in number of years of farming.

Ae = access to extension services measured by number of farm visits by extension officers.

Ed = educational level of export farmer measured in years of schooling.

Ac = access to credit facility by exporters expressed in terms of amount of loan accessed.

$$TE_{nex} = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \varepsilon_t \quad (4.5.4)$$

where subscript 'nex' in (2) above shows that it applies to pineapple non-exporters.

Z_{1i} = age of the non export farmer expressed in years.

Z_{2i} = experience of the non export farmer expressed in number of years of farming.

Z_{3i} = access to extension services by non export framer measured by number of farm visits by extension officers.

Z_{4i} = educational level of the non export farmer measured in years of schooling.

Z_{5i} = access to credit facility by non export farmer expressed in terms of amount of loan accessed.

Study Design and Data Collection

This was carried out through occasional visits to the study area at the proposal writing stage. The objectives of the visits were to explore the proposed study area, to gain some general insights into the nature of the problem, and to establish contacts with pineapple farmers.

The study used primary data based on 2009 farming season (March, 2009 to July, 2009). The data were collected from 120 pineapple farmers selected from four Districts (Mfantseman West, Gomoa East, Gomoa West and Effutu-Ewutu-Senya) in the Central Region.

The sampling method used was multistage sampling technique. The first stage involved a purposive sampling of the four districts based on the prevalence of pineapple farmers in these areas and size of farms.

Information for the study covered a whole year so as to include a complete sequence of operations since farming is seasonal. The process of data collection began with a survey for the construction of the sampling frame for both categories of farmers and drawing of various samples.

After the construction of the sampling frame, a simple random sampling using the lottery approach was used to select 20 pineapple non-export farmers from each district. Thereafter, 40 pineapple exporters in the study area were selected out of 42 farmers for the study. The two export farms were excluded since they were established less than a year ago and are yet to undertake their first harvest of pineapples as at the time of collecting the data.

Agricultural activities in the Central Region are continuous processes throughout the year. The reference period was therefore chosen to cover a period of one calendar year.

Populations of pineapple farmers producing solely for the local market and those exporters located in the pineapple growing areas in the Central Region were identified. Initially, a pilot test of the questionnaire was carried out. This served two main purposes: firstly, it ensured that the respondents and the enumerators understood the questions and secondly, it showed the suitability and the appropriateness of the questions and expected responses by the respondents.

The questionnaire was therefore, revised in the light of errors detected and omissions noted from the pilot survey.

Data obtained during the pre-testing exercise were coded and analyzed to gauge the accuracy of the questions. The enumerators were research assistants who understood the Fante language very well were selected and then trained for one week so that they can interpret the questionnaires to the non export farmers especially most of whom have low education background. The research assistants were also trained on how to administer the questionnaire through role-play. The author participated in data gathering while in the field as well as supervising the field team.

Information was gathered on different inputs and their market prices used in production and the physical quantity of output of pineapple farmers producing for the local market and exporters. Also, data were collected on types of farming systems, production practices, harvesting and post-harvest operations, packaging, marketing, etc. Besides, data were collected on the demographic profile of the farmers in the study area. Such variables included farmer's age, level of education, extension service visits, credit, farming experience, and some other relevant variables.

Definition of Variables

Tables 1 and 2 show a list of variables included in production functions of pineapple producer-exporters and non-exporters. The variables were picked based on the literature earlier reviewed. These variables include land, labour, fertilizers and chemicals, planting materials and annual capital charge.

Table 1: Variables Included in the Production Frontier Model of Pineapple Exporters

Variable	
Q	The maximum attainable output for a given level of all inputs and is measured in tons.
X_1	Land under pineapple cultivation in acres of the ith farm
X_2	Total amount of labour used measured in man days.
X_3	Quantity of fertilizer and chemicals used in kilograms.
X_4	Quantity of planting materials (suckers and plantlets) used in kilograms.
X_5	Annual capital charge measured in cedis (GH¢).

Land is defined as net area covered by pineapple and was treated as fixed input in line with (Lau and Yotopoulos, 1971). The authors argued that given the periodic nature of agricultural technology, it was reasonable to treat land as a fixed factor in the short run. For the pineapple non-exporters, simple farm tools such as hoes and cutlasses are used whiles agricultural machinery and equipment such as plough, tractors and spraying machine are hired. The exporters own almost all the heavy agricultural machinery and equipment used in production.

Labor is included in both models because it is one of the primary factors of production. It is measured in Ghana cedis (GH¢). Ali and Flinn, (1989) treat family labor as fixed factor and hired labor as variable factor. Both hired and family labor is treated as variable input in this study.

Fertilizers and chemicals used in production enhance productivity. Fertilizer and chemical used on the farm is a variable factor of production. Weier (1999) found fertilizer to have a positive and significant impact on output. However, Abdulai and Huffman (2000) registered negative sign for rice farmers in Northern Ghana.

One other important variable included in the models is annual capital charge to take care of the wear and tear of the implements used in cultivating pineapple. The export farmers use capital intensive farm implements such as tractors, ridgers, ploughs, etc. but the non-export farmers use simple farm tools such as hoes and cutlasses for cultivating pineapple.

Besides, planting materials such as suckers, plantlets and plastic mulch are included in the models since they form the cardinal inputs by which pineapples are grown.

Table 2: Variables included in the Production Frontier Model of Non-exporters

Variable	
Q	The maximum attainable output for a given level of all inputs and is measured in tons.
W_1	Land under pineapple cultivation in acres on the ith farm
W_2	Total amount of labour used measured in man days.
W_3	Quantity of fertilizer and chemicals used in kilograms.
W_4	Quantity of planting materials (suckers and plantlets) used in

	kilograms.
W_5	Annual capital charge measured in cedis (GH¢).

Variables Included in the Efficiency Models

The variables included the inefficiency models in equations 3 and 4 are presented in tables 3 and 4 respectively.

Table 3: Variables included in the Efficiency Model of Pineapple Producer-Exporters

List of Variables		Expected sign
Ω_0	Intercept term	
Ag	Age of the export farmer measured in years	+/-
Ex	Experience measured by years in pineapple production by farmer i.	+
Ed	Educational level of an export farmer in years	+
Ae	Agricultural extension services measured in number of visits to farm i.	+
Ac	Credit access by farmer i.	+

Much as older farmers are expected to be less technically efficient, they can be very efficient with age. Older farmers may be less efficient since they tend to be conservative and less receptive to modern and newly introduced agricultural technology. They are also physically not strong enough and would not be able to put in as much as the young farmers. However, as they learn by doing, with age older farmers become more experienced. Hence age (Ag) is hypothesized to have a mixture of positive or negative effects on technical efficiency.

Experience (Ex) in pineapple production should have a direct relationship with technical efficiency. As one gets proficient in the methods of production, optimal allocation of resources at his/her disposal should be achieved. Thus the more experienced one is, the higher the technical efficiency, and the lower the technical inefficiency. Bravo-Ureta and Rieger (1991) showed a positive relationship between economic efficiency and experience in a study of dairy farms in New England. In this study the researcher hypothesized a positive relationship between experience and technical efficiency.

Education (Ed) is hypothesized to affect efficiency positively, and it is captured for the respondent. Weier (1999) treated years of schooling of the household head separately from years of schooling of other adults in the household. Education enables farmers to access and use information on crop production and management. In addition it enables them to be more receptive to yield improving farming techniques.

Access to extension services (Ae) is a conduit for the diffusion of new technology among farmers. Thus it should reduce inefficiency levels among pineapple farmers through improvement in managerial ability. Ali and Byerlee (1991) review of a number of studies on economic efficiency reported negative influence of extension services on inefficiency. Therefore, access to extension services was hypothesized to have a positive effect on technical efficiency.

Adoption of new methods to increase efficiency does not depend only on availability of technologies; it also depends on whether the farmer has the money to buy the required inputs. Therefore, credit (Ac) should play a crucial role in inefficiency improvement and should have a negative relationship with technical efficiency. Lingard et al., (1983) found a positive relationship between credit access and efficiency level in Central Luzzon, Phillipines. Thus in this study credit was hypothesized to be positively related to technical efficiency.

Table 4: Variables Included in the Efficiency Model of Small Scale Non-Exporters

List of Variables		**Expected sign**
δ	Intercept term	
Ag	Age of the non-export farmer measured in years	+/-
Ex	Experience measured by years in pineapple production by farmer i.	+
Ed	Educational level of non-export farmer in years	+
Ae	Agricultural extension services measured in number of visits to farm i.	+
Ac	Credit access by farmer i.	+

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

The purpose of this chapter is to present socio-economic profile of the farmers in the study area, the econometric results from the frontier function and the results of the estimated parameters. The first part of the chapter presents demographic profile of the farmers which respond to objective number one of this study. This is followed by a discussion of the findings from the Cobb-Douglas (C-D) production frontier.

Socio-economic Profile of Pineapple Exporters and Non-Exporters

The present study looks at some selected socio-economic attributes of the pineapple exporters and non export farmers in the study area. This is to ascertain how changes in these variables would affect the technical efficiencies of both categories of farmers in the production of pineapples for export and the local market.

Table 5 reports of the age distribution of the two categories of farmers in the study area. About 17.5% of exporters were aged between 35 and 40 years compared with 35% of non export farmers who were in the same age bracket.

Thus it can be seen that more youth are into pineapple farming meant for local consumption probably as a result of less capital intensive nature and high profitability of pineapple farming.

Table 5: Age Distribution of Exporters and Non Export Pineapple Farmers

Age (Years)	Frequency	Percentage
	Pineapple Exporters	
<35	0	-
35 – 40	7	17.5
41 – 46	13	32.5
47 – 52	15	37.5
> 52	5	12.5
Total	**40**	**100**
	Non Export Farmers	
<35	5	6.25
35 – 40	23	28.75
41 – 46	17	21.25
47 – 52	29	36.25
> 52	6	7.5
Total	**80**	**100**

Source: Field Survey data, 2009.

In addition, majority (70%) of export farmers have ages ranging between 41 and 52 years as opposed to 57.5% of non-export farmers whose ages range between 41 and 52 years. The aim of the above analysis is to get an insight about the age distribution of farmers under study in order to determine whether age is an important factor that influences technical efficiency in pineapple farming.

Table 6: Years of Schooling of Pineapple Exporters and Non Export Farmers

Education (Years)	Frequency	Percentage
	Pineapple Exporters	
6 – 9	8	20.0
10 – 13	13	32.5
14 – 17	9	22.5
18 – 21	9	22.5
> 21	1	2.5
Total	**40**	**100**
	Non Exporters Farmers	
0 – 3	19	23.75
4 – 7	40	50.00
8 – 11	20	25.00
>11	1	1.25
Total	**80**	**100**

Source: Field Survey data, 2009

In their study of Swamp and Upland Rice production systems, Idiong et al (2007) found a positive correlation between education (years of schooling) and levels of technical efficiency of both production systems. They contended that farmers should therefore, be encouraged to improve their levels of education by registering in the Adult/Continuing Education Centre in the area. The level of education of farmers is likely to influence the level of efficiency in the pineapple farms in the study area. In Table 6, different ranges of years of schooling were used because while all large scale pineapple had had at least basic education, some of the non exporters have not had any formal education before. Majority (98.75%) of non export pineapple farmers have had up to 11 years of education and only one farmer has received more than 11 years of education. Again, 10% non export farmers are illiterates who have not been given any formal education neither have they attended Non-Formal Education classes before. Comparatively, the least number of years spent in school by pineapple exporters is 6 and majority (47.5%) have had more than 11 years of schooling. Besides, all pineapple exporters have had various levels of education up to the tertiary level. From the foregoing, the level of education of the exporters is higher than the non exporters which imply that the pineapple exporters would enhance their levels of efficiency since they are in a better position to use production information leading to increased yield.

Table 7: Experience of Pineapple Farmers

Experience (Years)	Frequency	Percentage
	Export Farmers	
<8	7	17.5
8 – 12	16	40.0
13 – 17	7	17.5
18 – 21	8	20.0
> 21	2	5.0
Total	**40**	**100**
	Non Export Farmers	
<8	17	21.5
8 – 12	15	18.5
13 – 17	20	25.0
18 – 21	16	20.0
> 21	12	15.0
Total	**80**	**100**

Source: Field Survey data, 2009.

Looking at Table 7, majority of pineapple exporters (95%) and non exporters (85%) have 21 years of experience in pineapple cultivation in the study area. Whereas 5% of exporters have more than 21 years experience, 12% of non export producers have more than 21 years experience in pineapple cultivation. Thus Table 7 reveals that farmers in both categories were quite experienced and have been exposed to pineapple farming techniques which this will go a long way to increase technical efficiency.

Institutional Attributes of Pineapple Exporters and Non Export Farmers

Some selected institutional attributes such as extension services and access to credit are included in the study to ascertain how changes in these variables would affect the technical efficiencies of the two groups of farmers in the production of pineapples for both export and the local market.

Table 8: Extension Services Received by Exporters and Non Export Farmers

Extension (no. of visits)	Frequency	Percentage
Export Farmers		
<2	16	40
2 – 3	21	52.5
4 – 5	3	7.5
> 5	0	-
Total	**40**	**100**

Non Export Farmers		
<2	2	2.5
2 – 3	25	31.5
4 – 5	38	47.5
> 5	15	18.5
Total	**80**	**100**

Source: Field Survey data, 2009.

Table 8 depicts the number of visits of extension officers to export and non export farmers respectively in a season. From table 8, 16 (40%) pineapple exporters either did not have extension contact or were visited at most once in a season by district extension officers. This is compared with 2.5% or 2 of the non export pineapple farmers in the same category. Again, as 79% of non export farmers had between 2 to 5 extension contacts in a season, 60% exporters accessed extension service. Besides, 15% of pineapple non exporters were visited more than 5 times in a season.

Ali and Byerlee (1991) review of a number of studies on economic efficiency reported negative influence of extension services on inefficiency. Bravo-Ureta and Rieger (1991) reported a positive relationship between extension services and economic efficiency for the dairy farms in New England, U.S.A. It can therefore be inferred from table 8 that non export pineapple farmers enjoyed more extension services relative to the exporters hence the level of efficiency among non exporters would be high as they are likely to be imbibed with new ways of cultivating pineapple.

Table 9: Access to Credit by Exporters and Non Export Pineapple Farmers

Credit	Frequency	Percentage
Exporters		
Accessed loans	38	95
Not Accessed loans	2	5
Total	**40**	**100**
Non Exporters		
Accessed loans	70	87.5
Not Accessed loans	10	12.5
Total	**80**	**100**

Source: Field Survey data, 2009.

In table 9, it could be seen that majority of farmers from both categories accessed loans from the various financial institutions. Thus 95% of pineapple export farmers contacted accessed various levels of loans to secure suckers, chemicals, fertilizers, and other inputs to produce pineapples for export as opposed to 5% who did not apply for any loan facility. These farmers contended that they did have any difficulty accessing bank loans notwithstanding the high interest rate but they have enough capital for their operations. On the other hand, 87.5% of the non export farmers accessed loan facilities and 12.5% did not access loans for their activities. It was observed that those who did access credit facilities complained of high interest rate and the refusal of some banks to grant them loans due to lack of collateral security. Ali and Flinn (1989) found a negative relationship between credit access and inefficiency level for Basmati rice farmers in Pakistani.

Descriptive Statistics

Table 10 presents the summary statistics of the various variables involved in the analysis of this work. They include the sample mean values and the standard deviations, together with the minimum and maximum values of each of the variables for the exporters as well as the non export farmers. The values in the summary statistics vary across pineapple exporters and non export farmers.

Table 10: Summary Statistics of Output, Inputs and Socio-economic Variables of Exporters and Non export Pineapple Farmers

	Export Farmers				Non Export Farmers			
Variable	**Max**	**Min**	**Mean**	**Std Dev**	**Max**	**Min**	**Mean**	**Std Dev**
Output	7800	1080	3109.3	1624.1	36	4	17.3	9.4
Land	600	90	253.75	128.54	6	0.5	2.7	1.4
Labour	159	1064	511.2	2460.1	98	12	46.8	21.5
Chem&Fert	37962	1623.8	17508.4	9068.4	312	83	221.1	69.6
Planting Mat.	8000	1325	3780	1781.1	600	50	249.3	131.7
Ann. Capt.	14000	2350	6273.6	2384.1	200	40	116.3	36.5
Age	58	39	46.4	5.0	57	32	44.2	6.3
Experience	24	4	12.58	5.25	34	3	14.2	6.9
Education	24	6	13.7	4.7	12	0	5.6	3.1
Extension	6	0	1.82	1.2	6	1	3.9	1.4
Credit	32000	0	2872	48003.5	600	0	1950	1648.1

Source: Field Survey data, 2009.

The relatively larger farm size among pineapple exporters is reflected in the amount of farm output being relatively higher for the exporters than for the non export farmers. The average pineapple export producer has an output of 3109.3 tons with a standard deviation of 1624.1 compared with the non export farmer whose average output is 17.3 tons with standard deviation 9.4. Given the higher standard deviation of 1624.1, it implies that the exporters exhibit high variability in their scale of operations compared to that of the non export farmers.

The farm sizes of non export farmers involved in the study are relatively small as compared to the exporters with relatively larger farm size. Farm size ranged between 0.5 and 6.0 acres for pineapple non exporters and 90 and 600 acres for exporters. This may be explained by the fact that pineapple exporters have to cultivate greater number of acres of land to produce more quantities of output in order to meet export orders.

The maximum and minimum labour effort put into production by exporters varies between 1064 and 159 man days whereas that for pineapple non exporters varies between 12 and 98 man days respectively. On the average pineapple exporters engage services of labour to the tune of 511.2 man days to cultivate one acre of land with a standard deviation of 2460.05 while the average labour effort needed for the cultivation of an acre of land on the part of non exporters is 46.78 man days at a standard deviation of 21.5. With a standard of 2460.1, the pineapple exporters exhibit higher variability of labour employment than the non exporters.

The exporters used more chemicals and fertilizers in production than the non exporters. The average quantity of chemicals and fertilizers used by pineapple non export growers is 221.1 kilograms with standard deviation 69.6. This is compared to that of the export farmers who use 17508.4 kilograms of chemicals and fertilizers on the average with standard deviation 9068.4. This high standard deviation implies very significant variability of chemical and fertilizer usage among exporters in relation to those who produce for the local market.

The annual capital charge which was used as a measure for equipment by non export farmers varies between GH¢40 and GH¢200 but that for the exporters ranges between GH¢2350 and GH¢1400. On the average, the annual capital charge for equipment is GH¢378035 for exporters with a standard deviation of GH¢2350. In contrast, non exporters set aside an average of GH¢116.3 as annual capital charge with a standard deviation of 36.5. The high annual capital charge for equipment used for cultivation by exporters can be attributed to the large number of acres of land they cultivate. Also, their operations are well integrated and capital intensive.

The quantity of planting materials (suckers, plantlets) used was very high for pineapple exporters. The exporters use a maximum of 8000 kilograms and a minimum of 1325 kilograms planting materials (suckers, plantlets, etc) per season. Those farmers who produce for the home market on the other hand plant between 50 and 600 kilograms each season.

There are remarkable variations in the socio economic variables of the pineapple exporters and non export farmers. The age of the exporters varies between 58 years and 39 years with average age of 46.46 years as opposed to 57 years and 32 years with average age of 44.23 years for the non export pineapple farmers. Thus pineapple export farmers are older than the non exporters on the average and this is likely to affect their technical efficiency levels.

With education, the exporters have more number of years of schooling that is 14 years on the average but the non exporters have more farming experience on the average (14 years). The non exporters having more experience can be attributed to the fact that they have over the years produced pineapples for local consumption until the 1980’s when exportation of pineapples begun.

The pineapple non exporters received more extension services from trained officers than the producer exporters. Extension officers visited the non export farmers 4 times on the average in a cropping season as opposed to 2 visits on the average for export farmers. This is because of the fact that most pineapple exporters interviewed revealed that they do not rely on extension officers from the Ministry of Food and Agriculture District office for advise as they have enough technical information on pineapple production. According to them they have well trained farm supervisors with all the requisite expertise and knowledge in pineapple cultivation hence do not rely on extension officers for their operations.

The exporters are able to contract a maximum of GH¢ 32,000.00 loans for their activities as compared to the non export farmers who obtained a maximum of GH¢600.00 to enable them finance their activities. In all, 12.5% of the non exporters could not contract any credit facility for their activities as against 5% of the exporters. The higher percentage of non exporters inability to access loans for their activities is attributable to the fact that their scale of operations are very low compared to the export farmers, the financial institutions find it difficult to grant them long term loans. Also, they do not have farm assets that can serve as collateral security.

The differences in the socioeconomic and institutional variables of the farmers in the study area are expected to reflect in their level of technical efficiency.

Summary Statistics of Output and Inputs variables in the Production Frontier Models of Pineapple Exporters and Non Export Pineapple Farmers

The summary statistics of input and output variables in the production frontier models of exporters and non export farmers are presented in tables 11 and 12 respectively.

Table 11: Summary Statistics of Output and Inputs in the Production Frontier of Pineapple Exporters

Variable	Unit	Mean	Standard Deviation
ln Output (Q)	tons	8.152	0.5649
ln Land (X_1)	acres	5.531	0.4751
ln Labour (X_2)	man days	6.133	0.5119
ln Chemicals & Fertilisers (X_3)	Kgs	9.636	0.6379
ln Planting Materials (X_4)	Kgs	12.042	1.3631
ln Annual Capital Charge (X_5)	GH¢	8.669	0.3729

Source: Field Survey data, 2009.

The above table shows the descriptive statistics of the production frontier model of pineapple exporters. The average export farmers cultivate 5.5 acres of land, hire labour to work for 6 man days, apply 9.6 kilograms of chemicals and fertilizers such as alliette, duiron, N. P. K. 15-15-15, magnesium nitrate, etc, use

12 kilograms of planting materials (suckers, plantlets, etc) and make provision for annual capital charge for equipment to the tune of GH¢8.7 to produce about 8 tons of pineapples within a season.

Table 12: Summary Statistics of Output and Inputs in the Production Frontier of Non Export Farmers

Variable	Unit	Mean	Standard Deviation
ln Output (Q)	tons	2.6769	0.6225
ln Land (W_1)	acres	0.8355	0.6078
ln Labour (W_2)	man days	3.7409	0.5050
ln Chemicals & Fertilisers (W_3)	Kgs	5.3420	0.3724
ln Planting Materials (W_4)	Kgs	9.9368	0.7197
ln Annual Capital Charge (W_5)	GH¢	4.7074	0.3583

Source: Field Survey data, 2009.

Table 12 presents the descriptive statistics of the production frontier model of pineapple farmers who target the local market. It can be seen that on the average, about 3 tons of pineapples are harvested by the pineapple non exporters. This they achieved by using an acre of land, employing labour to work for about 4 man days, applying 5.3 kilograms of chemicals and fertilizers such as alliette, duiron, N. P. K. 15-15-15, magnesium nitrate, etc , use about 10 kilograms of planting materials and set aside an amount of GH¢4.71 as annual capital charge for equipment usage.

Stochastic Production Frontier and Technical Efficiency Estimates

Equations (4.5.1) and (4.5.2) were estimated for both export and non export pineapple farmers using the Maximum Likelihood Estimates (MLE) method. This method makes use of the specific distribution of the disturbance term and is more efficient than the corrected ordinary least squares version (Bravo-Ureta et al, 1993). It is evident in tables 13 and 14 that the estimates of λ (3.573) and σ (0.861) for pineapple exporters and λ (2.106) and σ (1.063) for non export farmers respectively are large and significantly different from zero. These show a good fit and the correctness of the specified distributional assumption. The 5% significance level of σ is consistent with Hjamarson et al, (1996) and Sharma et al, (1997), implying that the conventional production function is not an adequate representation of the data sets.

Additionally, the estimate of γ, which is the ratio of the variance of farm-specific technical efficiency to the total variance of output, is 0.927 and 0.815 for the exporters and non exporters respectively. This indicates that for both groups of farmers, by far the greater percentage 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 significant contribution in the analysis.

Table 13: Maximum Likelihood Estimates of Variables in the Production Frontier Function of Pineapple Exporters

Variables	Parameter	Coefficient	Standard Error	t-ratio
Frontier Function				
Constant	β_0	4.3280	1.6198	2.67*
Land	β_1	1.6096	0.6516	2.47***
Labour	β_2	0.4453	0.5554	0.80
Chemicals & Fertilizers	β_3	-0.7882	0.2041	-0.27
Planting Materials	β_4	-0.0249	0.0750	-0.33
Annual Capital Charge	β_5	-0.3202	0.2742	-1.17**
Efficiency Model				
Intercept	δ_0	0.6664	1.0676	0.62
Age	δ_1	-0.0242	0.4828	-0.05
Education	δ_2	0.3533	0.2048	1.73***
Experience	δ_3	0.0234	0.0652	0.36
Extension	δ_4	-0.0984	0.0902	-1.09*
Credit	δ_5	0.3162	0 .1405	2.25**
Diagnostic Statistics				
Sigma	σ	0.861		
Sigma squared	σ^2	0.742		
Sigma-squared (u)	σ_u^2	0.688		

Sigma-squared (v)	σ_v^2	0.054
Lambda $\{\sigma_u/\sigma_v\}$	λ	3.573**
Gamma $\{\sigma_u^2/(\sigma_u^2+\sigma_v^2)\}$	γ	0.927
Log likelihood		-13.284

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

Source: Computed from Field Data, 2009.

It can be seen from table 13 that among the explanatory variables, the elasticity of land (1.61) was the highest. This implies that for pineapple exporters a 1 percent increase in land size will lead to 1.61 percent increase in pineapple production, with the use of all other farm inputs remaining at the mean level. The coefficient of land is positive and significant at the 1%, 5% and 10% levels. Although the elasticities of chemicals and fertilizers, planting materials and annual capital charge are negative, annual capital charge was significant at the 1% and 5% levels. The negative coefficients of chemicals and fertilizers (0.7882) and planting materials (0.0249) in table (13) indicate that a one percent increase in the amount of chemicals and fertilizers and planting materials will lead to a fall in pineapple output by 0.7882 and 0.0249 0 respectively. This shows over utilization of these inputs by pineapple exporters. The reasons may be due to the need to produce to meet strict export requirements and standards. Besides, these pineapple exporters are faced with the challenge to meet deadlines of export orders at all cost for fear of losing customers to their competitors. Again, the negative coefficient value of annual capital charge (0.3202) shows that a one percent increment in equipment inputs in production leads to 0.32 percent decrease in total output of pineapples produced. However, the positive coefficient elasticity of labour indicates that there is the need to invest more in that input since it will increase pineapple yield.

From table 14, it could be observed that land has the highest elasticity, which is 0.53. This means that for the non-export farmers, a 1 percent increase of land input in pineapple production will result in 0.53 percent increase in pineapple production, while the other inputs remain at the mean level. Thus for both groups of farmers, land is a major factor that has greater influence on pineapple output.

Table 14: Maximum Likelihood Estimates of Variables in the Production Frontier Function for Non Export Pineapple Farmers

Variables	Parameter	Coefficient	Standard Error	t-ratio
Frontier Function				
Constant	β_0	-1.9512	1.2394	-1.57**
Land	β_1	0.5334	0.1341	3.98**
Labour	β_2	- 0.2089	0.0920	-0.27
Chemicals & Fertilizers	β_3	-0.4288	0.1564	-2.74*
Planting Materials	β_4	0.2089	0.0920	2.27*
Annual Capital Charge	β_5	0.0313	0.0729	0.43
Efficiency Model				
Intercept	δ_0	0.1150	0.0652	1.76*

Age	δ_1	-0.5613	0.1318	-4.26**
Education	δ_2	-0.0390	0.1284	-0.30
Experience	δ_3	0.0459	0.0708	0.65
Extension	δ_4	0.1889	0.0894	2.11**
Credit	δ_5	0.4327	0.1545	2.80**
Diagnostic Statistics				
Sigma	σ	1.063		
Sigma squared	σ^2	1.131		
Sigma-squared (u)	σ_u^2	0.922		
Sigma-squared (v)	σ_v^2	0.209		
Lambda $\{\sigma_u/\sigma_v\}$	λ	2.106**		
Gamma $\{\sigma_u^2/(\sigma_u^2 + \sigma_v^2)\}$	γ	0.815		
Log likelihood		21.001		

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

Source: Computed from Field Data, 2009.

The estimates of the parameters of the stochastic frontier production model of non export pineapple revealed that estimated coefficients of land, planting materials and annual capital charge were positive and that of labour and chemicals and fertilizers were negative. Land was significant at the 1% and 5% levels respectively but that of chemicals and fertilizers and planting materials were significant at the 1% level respectively. Labour and annual capital charge on the other hand were insignificant, implying that no significant differences in production of pineapples were made by increase in labour and amount set aside to take care wear and tear of the equipment used by non export pineapple farmers. The positive coefficient values of labour (0.5334), planting materials (0.2089) and annual capital charge (0.0313) indicate that a one percent increment in the above mentioned inputs will lead to these inputs increasing pineapple output to the tune of (0.53), (0.21) and (0.03) respectively.

Technical Efficiency in Pineapple Production

While the predicted technical efficiencies of individual of pineapple farmers are presented in Appendix 1, the distribution of technical efficiencies of both groups of farmers are presented in tables 15 and 16. Besides, the technical efficiency estimates and output loss of the farmers are shown in tables 17 and 18 respectively.

Table 15: Distribution of Technical Efficiency Estimates of Pineapple Exporters

Technical Efficiency		Frequency	Percentage
<0.10		3	7.50
0.10 – 0.20		11	27.50
0.30 – 0.40		6	15.00
0.50 – 0.60		8	20.00
0.70 – 0.80		4	10.0
0.90 – 1.00		8	20.0
Minimum	0.008		
Maximum	0.992		
Mean Technical Efficiency	0.50.8		
Std Deviation	0.308		
Skewness	0.043		
Kurtosis	-1.402		
Total		**40**	**100**

Source: Field Survey data, 2009.

The estimated technical efficiency (table 15) among pineapple exporters ranged between 0.008 and 0.998 with a mean of 0.508 at standard deviation 0.308. In the same way, that for non export farmers (table 16) ranged between 0.0145 and 0.995 with a mean of 0.552 at standard deviation 0.299. This implies that pineapple farmers in both groups are operating at 50.8% and 55.2% level of efficiency respectively. What this means is that on the average, the pineapple exporters and non-exporters could increase their respective pineapple output levels by 49.2% and 44.8% without additional resources or through proper (i.e., more efficient) use of existing inputs and technology. Differently put, on the average about 49% and 45% of the technical potential of the exporters and non export pineapple farmers could not be realized in increasing pineapple output. Frankly speaking, these levels of efficiencies are quite low and provide much room for efficiency gain and a cause for concern for the respective groups of farmers and policy makers alike.

Table 16: Distribution of Technical Efficiency Estimates of Non Export Pineapple Farmers

Technical Efficiency	Frequency	Percentage
<0.10	8	10.00
0.10 – 0.20	19	22.50
0.30 – 0.40	14	18.70
0.50 – 0.60	13	16.30
0.70 – 0.80	16	20.00
0.90 – 1.00	10	12.50
Minimum	0.015	
Maximum	0.995	
Mean Technical Efficiency	0.552	

Std Deviation	0.291		
Skewness	-0.149		
Kurtosis	-1.848		
Total		**80**	**100**

Source: Field Survey data, 2009.

About 7.5% of pineapple exporters had technical efficiencies below 0.1, and 10% of non export farmers were found in the same category. Majority of both categories of farmers that is 27.5% representing 11 pineapple exporters and 22.50% representing 19 non export pineapple farmers were producing within a technical efficiency range of 0.10 to 0.20. Also, the results reveal that 35% of the exporters operate below their overall mean technical efficiency level (50%) while 32.5% of non-export farmers operate below their overall mean technical efficiency level (55%).

Though the mean levels of efficiency are low, they are comparable to those from other African countries. For instance Weir (1998) and Weir and Knight (2000) found mean efficiency levels of about 55% among Ethiopia cereal crop producers. However, Chirwa (2007) found the mean technical efficiency among smallholder maize farmers in Southern Malawi to be 46.23% which is lower than what has been estimated in this study.

Table 17: Technical Efficiency Distribution and Output Loss of Export Farmers

TE Range	Mean TE (%)	Percent of Farmers in each category
<0.10	5.2	5.0
0.10 – 0.20	30.5	30.0
0.30 – 0.40	43.8	12.50
0.50 – 0.60	57.8	22.50
0.70 – 0.80	80.9	10.0
0.90 – 1.00	94.7	20.0

Source: Field Survey data, 2009.

The results in tables 17 and 18 reveal that 12.5% of pineapple exporters are operating below the 50% efficiency level as compared to 26.25% non-export pineapple farmers who operate below the same efficiency level. These results depict the fact that there is a high amount of inefficiency use of resources among the two groups of pineapple producers which could provide considerable amount of cost saving or expansion in production or both.

Table 18: Technical Efficiency Distribution and Output Loss of Non Export Pineapple Farmers

TE Range	Mean TE (%)	Percent of Farmers in each category
<0.10	3.99	3.75
0.10 – 0.20	19.46	11.25
0.30 – 0.40	40.86	26.25
0.50 – 0.60	55.99	17.50
0.70 – 0.80	81.91	32.50
0.90 – 1.00	93.82	8.75

Source: Field Survey data, 2009.

The analysis in tables 17 and 18 reveal that a major gain in output is possible if pineapple farmers who target both the local and export market operate at full efficiency.

Table 19: Test of the Difference between the Mean Technical Efficiency of Pineapple Exporters and Non Exporters

Farm Group	Observations	Mean
Exporters	40	50.8
Non Exporters	80	55.2
All Sample	120	53.8
Degrees of freedom	118	

t-ratio	-0.7683
p-value	0.4439

Source: Field Survey Data, 2009.

From table 19, the t-statistic is -0.7683 with 118 degrees of freedom. The corresponding two- tailed p-value is 0.4439. This is greater than the alpha value of 0.05. It can therefore, be concluded that the difference of mean technical efficiency in pineapple production between exporters and non exporters is not statistically significantly different from zero.

Technical Efficiency and Socio-economic characteristics

Socio-economic, demographic, environmental, institutional and non-physical factors are expected to affect efficiency. (Kumbhakar and Bhattachary, 1992, Ali and Chaudhry, 1990). Using the specification of equations (4.5.3) and (4.5.4), an attempt is made to investigate the determinants of technical efficiency. In this case, the coefficients of the explanatory variables in the technical efficiency models are of paramount importance in terms of making policy options. The sources of efficiency are examined using the estimated δ-coefficients in table 22 associated with the efficiency variables equations (4.5.3) and (4.5.4). These efficiency factors are specified in relation to socio-economic characteristics of both non export and non export pineapple farmers. And they include age of the farmer, education, farmer’s years of farming experience, extension contact and amount of credit accessed by the farmer in a season.

Correlation tests are conducted to detect multi-colinearity among output and the variables affecting pineapple production and among the variables affecting pineapple output themselves are presented in appendix 5 and 6. The correlation matrix of the level of technical efficiency and the variables affecting technical efficiency are also presented in tables 20 and 21.

Table 20: Correlation Matrix for Technical Efficiency and Variables affecting Technical Efficiency of Pineapple Exporters

	TE	Age	Education	Experience	Extension	Credit
TE	1.0000					
Age	-0.0399	1.0000				
Education	0.0326	-0.1667	1.0000			
Experience	-0.0204	0.0819	0.2070	1.0000		
Extension	-0.1088	-0.0050	-0.1818	0.0611	1.0000	
Credit	0.0066	0.0520	0.0204	0.0727	-0.1280	1.0000

Source: Field Survey Data, 2009.

The correlation matrices involving technical efficiency and the efficiency variables of pineapple exporters and non exporters from tables 20 and 21 show positive and negative correlations among the efficiency variables. Also there is a mixture of correlation between technical efficiency and the efficiency variables. For instance education and access to credit are positively correlated with the level of technical efficiency of pineapple exporters. Thus as the export farmers acquire more education and have unlimited access to credit will lead to improvement in their technical efficiency levels.

Table 21: Correlation Matrix for Technical Efficiency and Variables affecting Technical Efficiency of Pineapple Non Exporters

	TE	Age	Education	Experience	Extension	Credit
TE	1.0000					
Age	-0.0043	1.0000				
Education	-0.0686	-0.0007	1.0000			
Experience	-0.0322	-0.2082	0.1938	1.0000		
Extension	0.1045	0.0338	-0.3330	-0.0160	1.0000	
Credit	0.0105	-0.0137	-0.0252	-0.2166	-0.0129	1.0000

Source: Field Survey Data, 2009.

On the other hand, access to extension services and credit are positively correlated with the technical efficiency levels of pineapple non exporters. From appendix 5 and 6 and tables 20 and 21, it could be realized that there are no large correlations between pineapple yield and variables affecting yield and the technical efficiency and the explanatory variables and among the explanatory variables themselves. This implies that multicollinearity was not a problem for both groups of farmers.

Table 22: Efficiency Models of Pineapple Exporters and Non Exporters

Variables	Parameter	Coefficient	Standard Error	t-ratio
		Pineapple Exporters		
Intercept	δ_0	0.6664.	1.0676	0.62
Age	δ_1	-0.0242	0.4828	-0.05
Education	δ_2	0.3533	0.2048	1.73 ***
Experience	δ_3	-0.0234	0.0652	-0.36
Extension	δ_4	-0.0984	0.0902	-1.09*
Credit	δ_5	0.3162	0 .1405	2.25**
No. of Observations	40			
		Pineapple Non Exporters		
Intercept	δ_0	1.4113	0.2848	4.96***
Age	δ_1	-0.5613	0.1318	-4.26**
Education	δ_2	-0.0390	0.1284	-0.30
Experience	δ_3	0.0459	0.0708	0.65
Extension	δ_4	0.1889	0.0894	2.11**
Credit	δ_5	0.4327	0.1545	2.08**
No. of Observations	80			

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

Source: Computed from Field Data, 2009.

With regard to the factors which influence efficiency among the sample pineapple farmers in each category, the estimates of the technical efficiency effects models provide essential insights. The parameter estimates in table 22 above have the relevant signs which indicate the impact of explanatory variables on technical efficiency. It is therefore, important to note that explanatory variables with a large impact should be given much attention with regard to efforts to improve efficiency in pineapple production among exporters and non-exporters in the study area.

Age is a variable included in the model to assess the impact of age on the level of technical efficiency. It is commonly believed that age can serve as a proxy for farming experience, as the farming system in the farming area is of the traditional type. Thus older farmers have the greater farming experience. The estimated coefficient for this variable is negative for pineapple exporters and non export pineapple farmers, implying that older farmers among both groups of farmers are less technically efficient. This result can be explained in terms of adoption of modern technologies. The variable was however significant at 1% and 5% levels for the non exporters. Hussain (1989) contended that older farmers are less likely to have contact with extension workers and are equally less inclined to adopt new techniques and modern inputs, whereas younger farmers, by virtue of their greater opportunities for formal education, may be more skilful in the search for information and the application of new techniques. This will lead to improvement in their levels of technical efficiency.

Education enhances the acquisition and utilization of information on improved technology by the farmers as well as their innovativeness (Dey et al, 2001; Onyenweaku et al, 2005). The variable education was used as a proxy for managerial input. Increased farming experience coupled with higher level of educational achievement may lead to better assessment of the importance and complexities of good farming decision, including efficient use of inputs. The coefficient of education is positive as expected for the exporters and statistically significant at 1%, 5% and 10% level but negative for non exporters. The implication here is that the more educated exporters are more likely to be efficient as compared to their less educated counterparts, perhaps as a result of their better access to information and good planning (Dhungana, et al 2004). Thus farmers with more years of schooling tend to more technically efficient in pineapple production, probably due to their ability to acquire technical knowledge, which make them move close to the frontier output. This agrees with comparable findings by Battese et al (1996), Coelli and Battese (1996) and Seyoum et al (1998). Adesina and Djato (1996), however, concluded that educated farmers are not more efficient that non-educated farmers since the latter may have an empirical knowledge obtained from cumulative farming experience. Kalirajan and Shand (1985) shared a similar view by arguing that although schooling is a productive factor, farmer's education is not necessarily related significantly to their productivity achievement. Therefore illiterate farmers without the ability to read and write can understand a modern production technology as well as their educated counterparts provided the technology was properly. The negative coefficient of education for non exporters on the other hand shows that these farmers are less efficient in the production of pineapples. This may be due to less years of schooling which hinder their ability to respond readily to new agricultural technology to enable them produce close to the frontier output.

The coefficient of experience is estimated to be positive as expected for non export farmers but negative for export farmers. The variable is however, insignificant for both categories of farmers. This means that farmers with more years of experience tend to be less experienced in pineapple production hence less technically inefficient. This confirms with findings of Coelli and Battess (1996) who reported negative production elasticity with respect to experience for farmers in two villages in India. Rahman (2002) showed similar results for Bangladesh rice farmers. Sharma et al., (1999) studying allocative and economic efficiencies in swine production in Hawaiian farmers also had similar results.

Agricultural extension represents a mechanism by which information on new technologies, better farming practices and better management can be transmitted to farmers. The estimated coefficient associated with extension services was negative for pineapple exporters at 1% significance but positive for pineapple non exporters. The variable was however significant for non export farmers at 1% and 5% levels. These results show that access to extension advice by pineapple farmers help to increase technical efficiency in pineapple production. The results are consistent with findings obtained by other researchers (Bravo-Ureta and Rieger, 1991; Seyoum et al., 1998; Rahman, 2002). These results therefore, serve to emphasize the important role of extension services in reducing inefficiency in pineapple production especially for non export pineapple farmers.

Credit is a variable used to estimate the effect of credit on technical efficiency of pineapple exporters and non exporters. Access to credit is expected to ease the financial constraint faced by pineapple farmers and enhance the acquisition of the needed farm inputs. Results of the exporters and non exporters show positive coefficient for credit signifying that access to credit help farmers to improve efficiency. The variable is statistically significant at the 1% and 5% levels for both groups of farmers. This implies that availability of credit play a vital role for attaining higher level of technical efficiency. Thus farmers who get loan are technically less inefficient as compared to the farmers who do not have access to loan. This result is in line with that of Ali and Flinn (1989), Kalirajan and Shand (1986), and Obwona (2006).

Marginal Effects

The parameters estimated in the production functions and efficiency models in tables 13, 14 and 22 depict the direction of the effects the various variables have on efficiency levels only (where a negative sign for an estimated parameter indicates that the variable reduces technical efficiency and vice versa). The marginal effects of these variables on technical efficiency can be quantified by partial differentiation of the technical efficiency predictor with respect to each variable in the production and efficiency functions respectively.

Tables 23 and 24 presents results of partial differentiation of the technical efficiency function with respect to each of the factor input and efficiency variables, evaluated at their mean values or with a value of one for dummy variables and where the residuals εt are calculated at the mean values of the dependent and independent variables in the stochastic frontier function (Wilson, et al., 2001). The partial differentiation was computed using Stata (9.0) software programme. The marginal effects of the factor inputs and efficiency variables are shown in tables 23 and 24. These tables have different interpretations, a positive sign indicate an increase in technical efficiency and vice versa.

The marginal effect of land implies that an additional acre of land cultivated would improve technical efficiency by 48.54% and 22.92% respectively for pineapple exporters and non exporters. This is equivalent to an increased yield of 6 tons for the exporters but only 1 ton in the case of non export farms.

Table 23: Marginal Effects of the Frontier and Efficiency Measuring Variables of Pineapple Exporters

Variable	Change in TE	Change in TE in Percentage	Change in tons per acre
Frontier Variables			
Land	0 .4854	48.54	6.29**
Labour	0.2504	25.04	9.58*
Chem&Fert	-0.0777	-7.77	-12.04

Planting Mat.	-0.0136	-1.36	-9.44
Annual Capital Charge	0.3862	38.62	8.61
Efficiency Variables			
Age	-0.0698	-6.98	-3.78**
Education	0.0121	1.21	1.54
Experience	0.0249	2.49	2.51
Extension	0.0706	7.06	3.81
Credit	-0.0165	-1.65	-7.50

Source: Field Survey data, 2009.

The quality and quantity of labour is an important factor which promote production efficiency, hence any additional labour employed is expected to increase technical efficiency by 25.04 for pineapple exporters and this translate into increased pineapple output to the tune of 10 tons. But for the non exporters the marginal change (loss in technical efficiency) for an additional labour employed is 28.63 percent and this is equivalent to 4 tons of pineapple. For both categories of farmers, an additional application of chemicals and fertilizers used in pineapple cultivation reduces technical efficiency by 7.77 and 21.53 percent respectively. This may mean excessive use of these inputs. Besides, an additional kilogram of planting materials used in pineapple cultivation decreases technical efficiency by 1.36 percent in the case of pineapple exporters. Comparatively, any additional kilogram of planting materials used in production by non exporters increases technical efficiency by 13.36 percent. Finally, annual capital charge has a marginal effect of 38.62 and 46.78 percent respectively for the two groups of farmers. These can be converted to approximately 9 tons and 5 tons of pineapples produced respectively.

Age is significant in the efficiency models of both exporters and non export pineapple farmers. The marginal change (loss in technical efficiency) for an additional age attained is 6.98 percent for pineapple exporters and this can be converted to approximately 4 tons of pineapples produced. However, for the pineapple non exporters the marginal change (loss in technical efficiency) of an additional age attained is 7.67 percent and this is equivalent to 4 tons of pineapple output. Education is an important factor that enhances production efficiency, in this sense, pineapple export farmers are able to increase their level of technical efficiency by 1.2 percent. This is can be converted to 3 tons of pineapples produced. The level of education is significant at 1% and 5% levels of significance in the efficiency model of the exporters. On the other hand, an additional educational attainment by non exporters reduces technical efficiency by 35.33 percent. For experience, an additional year of pineapple cultivation is expected to bring about technical efficiency gain to the tune of 2.49 and 20.98 percent for pineapple exporters and non export farmers respectively. These translate into 3 tons and 2 tons of pineapple yield produced per acre among the two groups of farmers under study.

Table 24: Marginal Effects of the Frontier and Efficiency Measuring Variables of Non Export Farmers

Variable	Change in TE	Change in TE in Percentage	Change in tons per acre
Frontier Variables			
Land	0.2292	22.92	0.84*
Labour	-0.2863	-28.63	-3.74
Chem&Fert	-0.2153	-21.53	-5.34
Planting Mat.	0.1136	11.36	9.94**
Annual Capital Charge	0.4678	46.78	4.71
Efficiency Variables			
Age	-0.0767	-7.67	-3.88 **
Education	-0.3533	-35.33	-2.69
Experience	0.2098	20.98	2.37
Extension	0.0782	7.82.	1.28*
Credit	0.0132	1.32	11.26

Source: Field Survey data, 2009.

As noted earlier, extension is the conduit for diffusion of new technology among farmers and this helps to increase efficiency in production. About 7.06 percent export farmers who had access to extension services are technically efficient as opposed to about 7.82 percent non export pineapple farmers visited by extension officials. The variable is significant in the efficiency model of the non exporters at 5% level but insignificant in the model of the pineapple exporters. Although some of the non exporters complained about difficulties in accessing bank loans due to lack of adequate collateral security, 1.32 percent who had access to some form credit are technically efficient. This is equivalent to 11 tons of pineapples produced. Comparatively, 1.65 percent of export farmers who had access to loans are technically inefficient.

From the foregoing, the results of the marginal effects of the variables in the stochastic frontier and the efficiency models of the two groups of farmers indicate that land, labour, annual capital charge, education, experience and extension had positive influence in enhancing the level of technical efficiency of the pineapple exporters. However, application of chemicals and fertilizers, planting materials and access to credit exerted negative influence on efforts aimed at improving technical efficiency. On the other hand, for pineapple non exporters, the results show that land, planting materials and annual capital charge all had positive influence in improving technical efficiency of these farmers. However, labour, chemicals and fertilizers and education had negative impact on technical efficiency improvement.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This study set out to compare the technical efficiency levels non-export pineapple farmers and exporters in the Central Region of Ghana. It is an undeniable fact that pineapple production has assumed a very great importance since the introduction of the Structural Adjustment Programme in Ghana with export of the fruit growing from almost zero in 1983 to about 42,000 tonnes in 2006.

Since pineapple is one of the major fruits consumed locally and exported to countries such as Italy, Belgium, France, etc hence its technical efficiency levels are very crucial to production, the attainment of both food and income security for farmers.

The main issues addressed in this study were first, whether pineapple farmers are producing at the production frontier. Second, if not how this translates into output levels, and exploration of the main determinants of technical efficiency levels in pineapple production. Third, a comparison of the factors affecting technical efficiency levels among pineapple farmers who target the local market and the exporters in the Central Region.

In chapter one, the background information of the whole study and the main objectives were stated. Chapter two gives a theoretical exposition of the approaches for the measurement of economic efficiency, an empirical review on technical efficiency in agriculture and Leibenstein's technical inefficiency (X-inefficiency) and managerial slack.

The literature reviewed in chapter two highlighted the fact that there are two major strands in the theoretical developments in frontier modeling to handle efficiency measurements. These frontier approaches to the measurement of efficiency are the parametric approach and nonparametric approach. The parametric approach involves econometric methods, whiles the nonparametric approach employs mathematical programming. The parametric approach relies on a parametric specification of the production function, cost function, or profit function fitted to the data.

The literature reviewed also highlighted the fact that the efficiency levels estimated depend on the approach used. In the case of deterministic models, all the observed inefficiencies are attributed to differences in farmers' practices, whereas in the stochastic model, there is an error term that is split between the observed (μ) and the unobserved (ν) components. The observed inefficiency (μ) is interpreted as inefficiencies due to technical and allocative inefficiencies of individual farmers and the unobserved (ν) is attributed to random factors, such as weather and policy changes. The empirical review on technical efficiency in agriculture demonstrate that all the studies were conducted on major agricultural enterprises such as rice, dairy, aquaculture, etc. Econometric frontier and Data Envelopment Analysis (DEA) approaches were adopted in the above mentioned studies.

The literature review also show that technical inefficiency was a serious problem and it is therefore, of prime importance to measure technical inefficiency and its causes. The main causes of technical inefficiency included poor managerial qualities of the producers. Agricultural, industrial and institutional productivity can be enhanced by improving managerial qualities (technical skill and knowledge) of the actors involved in production.

Summary

In the present study the Cobb-Douglass productions were estimated to determine the impact of different variables in pineapple production and estimate the technical efficiency levels of export and non export pineapple farmers in the study area.

Analysis from Cobb-Douglass model of pineapple export farmers showed that the variables land and labour have positive effect on technical efficiency as against the negative effect of chemicals and fertilizers, planting materials and annual capital charge on technical efficiency. The model of non export farmers showed that the variables (land, planting materials and annual capital charge) except labour and chemicals and fertilizers had positive effect on technical efficiency. Analysis of technical efficiency levels of the sampled pineapple farmers revealed that they were not operating at the production frontier since they had different levels of efficiency.

On the whole, pineapple exporters and non exporters achieved mean technical efficiency of 51% and 55% respectively. This is pointing to the fact that there is a scope for further increasing pineapple output meant for the local and export market by 49% and 45% respectively given the current state of technology available.

In an attempt to analyze the factors which influence efficiency of exporters, five factors were identified. These were age, education, experience, access to extension services and access to credit. For pineapple export farmers, education, experience and access to credit had positive sign but education and access to credit were statistically significant. In the case of non export farmers, experience, extension and access to credit had positive sign while age and education had negative sign. Age, education, extension and credit were found to be significant.

Education was found to have significant impact on efficiency among exporters and non export pineapple farmers. Thus to improve efficiency in pineapple production efforts should be made to improve the level of education of both groups of pineapple growers especially the non exporters.

According to the results, farmer's years of experience correlates with their ages and as labour productivity falls with age, younger farmers tend to be more productive than older ones due to arduous nature of farming activities.

Extension service was found to be significant and influence efficiency negatively for export farmers but positively in the case of non export farmers at the significance level of 1% and 5% respectively. Thus more extension contacts should be extended to pineapple non export farmers in to increase their levels of efficiency since extension access is a necessary lubricant to adoption of new technology.

Access to credit was found to be significant at the 1% and 5% levels and influence efficiency positively among the two categories of farmers.

Finally, calculation of marginal effects has shown that for pineapple exporters, land, labour, annual capital charge, education, experience and extension increase technical efficiency by 48.54, 25.04, 38.62, 1.21, 2.49 and 7.06 percent respectively from the current level of 49 percent. On the other hand, for non exporters, land, planting materials, annual capital charge, experience, extension and credit increase technical efficiency by 22.92, 11.36, 46.78, 20.98, 7.82 and 1.32 percent respectively from the current level of 52 percent. However, labour, and application of chemicals and fertilizers are expected to decrease technical efficiency by 28.63 and 21.53 percent respectively among large scale pineapple producer exporters.

Conclusions and Policy Recommendations

In order for pineapple farmers to be competitive and profitable, achieving higher levels of technical efficiency is the key. The ability of technically efficient farmers to use fewer resources to produce the given level of output has positive linkage effect on their levels of income and public welfare as well.

The main objective of this study was to compare the technical efficiency of small scale pineapple farmers who produce for the home market and those who produce for the external market in the Central Region of Ghana. The subsidiary objectives were to estimate the production frontier functions, compare the technical efficiency of large scale and small scale pineapple farmers and explain inefficiency levels observed.

The study results from the production frontier function showed that for pineapple exporters, the major variables affecting technical efficiency were land and labour. Presently, pineapple exporters and non export farmers operate an average of 253.75 and 2.71 acres of land respectively. These results imply that there is the need to increase land area under pineapple cultivation so as to improve the technical efficiency levels of both exporters and non export pineapple farmers. This can be achieved if the government provides incentives to traditional authorities to release more land especially for the youth to engage in pineapple production. However, expanding land acreage may imply increasing labour cost which will not be ideal for non exporters since labour influenced their levels of technical efficiency negatively. This therefore, suggests that land-augmenting technologies approach such as development of more improved pineapple varieties should be adopted since land acquisition for agricultural purposes is a national issue due to the existing land tenure system. This goes a long way to re-enforce the need for the government to support research institutions in the country with the required resources to enable them come up with high yielding pineapple varieties to be released to farmers. Again, for pineapple non export farmers planting materials contributed positively to their levels of technical efficiency but planting material was statistically significant. This means that efforts should be made to make these planting materials readily available at the market and at competitive prices to enable them employ more of these inputs to increase output for the local market.

The results from the stochastic frontier estimation also showed that the mean technical efficiency of non export and export pineapple farmers given the Cobb-Douglass model were 55.2% and 50.8% respectively, indicating that on the average non export pineapple farmers have high technical efficiency levels than their exporter counterparts. The difference-of-mean test shows that the difference of mean technical efficiency between the two groups is not statistically different from zero. However, there is room for both groups to increase their output levels by 44.8% and 49.2% respectively without increasing the levels of inputs used. It can therefore, be shown that the pineapple farmers in both groups operate at very low levels of technical efficiency.

Several factors affect technical efficiency. For non exporters, these include; age, extension contacts and credit access. All these were statistically significant except education and experience. On the other hand, for pineapple exporters, education and credit were significantly related and all had expected the signs. Thus from the results older non export farmers are more efficient than the younger ones. This could be due to good managerial practices they have learnt over the years hence, younger farmers should be encouraged to work hand in hand with older farmers. The Youth in Agriculture Programme introduced by the government would go a long way to motivate young people to venture into pineapple farming as a source of living. Farmers with higher levels of education were found to be more efficient than the less educated. Thus there is the need for the government and other nongovernmental organizations to design policies to promote formal education as a means of enhancing efficiency in pineapple production. This would enable farmers make better technical decisions concerning allocation of their production inputs effectively. For instance it would be easier for better educated farmers to grasp information passed onto them by extension officers. The government should therefore as matter of urgency consider increasing educational facilities in the study area. Nongovernmental organizations can also assist by investing in educational infrastructure especially at the basic level and organization of refresher courses for pineapple farmers on basic farming techniques, marketing, pricing and records keeping to enhance their efficiency.

Extension was also found to influence technical efficiency significantly for small scale pineapple farmers. This calls for policy intervention to ensure provision of well trained extension officials for disseminating extension information to farmers to raise efficiency. This can be achieved by government increasing funding to the tertiary institutions in the country to train more extension officers to assist farmers. In addition, agricultural research institutions in the country should be well resourced to undertake research to come out with high yielding pineapple varieties.

Efforts aimed at facilitate availability of credit for farmers through the promotion of credit co-operatives and other micro credit avenues can be a very useful policy for increasing agricultural productivity. The study found access to credit as a factor that influenced efficiency significantly for both categories of pineapple farmers. The technical efficiency levels of those farmers who had access to credit were enhanced than those who do not. These findings imply relevant policy directives by the government to loose the various constraints that farmers face to enable them to achieve a higher level of technical efficiency. The various financial institutions should be motivated through tax incentives to extend loans to pineapple farmers at moderate interest rates to enable them employ more factor inputs to expand their farms and produce more for both local and export market. The government can also guarantee such loans on behalf of these pineapple farmers.

Recommendations for Further Research

This study covered pineapple growing areas in the Central Region only. Hence, there is the need to widen the scope to cover all pineapple growing areas in Ghana. Secondly, to know what is happening to technical efficiency levels, we need good panel data on the fruit to trace the impact of the technology generated on productivity. This can only be possible when longitudinal studies are carried out systematically. Besides, the introduction of a new variety MD2 by Costa Rica has brought about changes in the demand for Ghana’s Smooth Cayenne at the world market. Finally, this study limited itself to commodity production issues, yet export and consumption issues are equally important in improving technical efficiency of pineapple farmers. Thus a study to examine pineapple export marketing issues is pertinent.

Though the present study looked at technical efficiency, a study on allocative efficiency would probably give more insight to the efficiency studies. It would also be interesting to look at technical efficiency and allocative efficiency using panel data from other pineapple growing areas in Ghana to evaluate technical efficiency among the regions.

Besides, it is suggested that a study on allocative efficiency using input and output prices might reveal differences in technical efficiency among producer exporters and non exporters in terms of producers' ability to utilize cost minimizing input ratios.

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APENDICES

Appendix 1: Predicted Technical Efficiencies of Pineapple Export Farms

Farmers Number	**Technical Efficiency**	**Farmers Number**	**Technical Efficiency**
1.	0.174143	21.	0.450776
2.	0.869223	22.	0.135759
3.	0.49578	23.	0.601195
4.	0.571791	24.	0.650524
5.	0.20143	25.	0.03084
6.	0.951677	26.	0.551988
7.	0.334697	27.	0.157614
8.	0.153614	28.	0.865474
9.	0.998079	29.	0.045617
10.	0.965718	30.	0.935291
11.	0.72587	31.	0.914563
12.	0.593513	32.	0.961796
13.	0.661031	33.	0.203775
14.	0.167832	34.	0.204165
15.	0.839774	35.	0.101665
16.	0.224689	36.	0.908432

17.	0.354276	37.	0.326778
18.	0.008779	38.	0.501119
19.	0.152225	39.	0.906946
20.	0.33904	40.	0.689984

Mean Technical Efficiency = 0.508

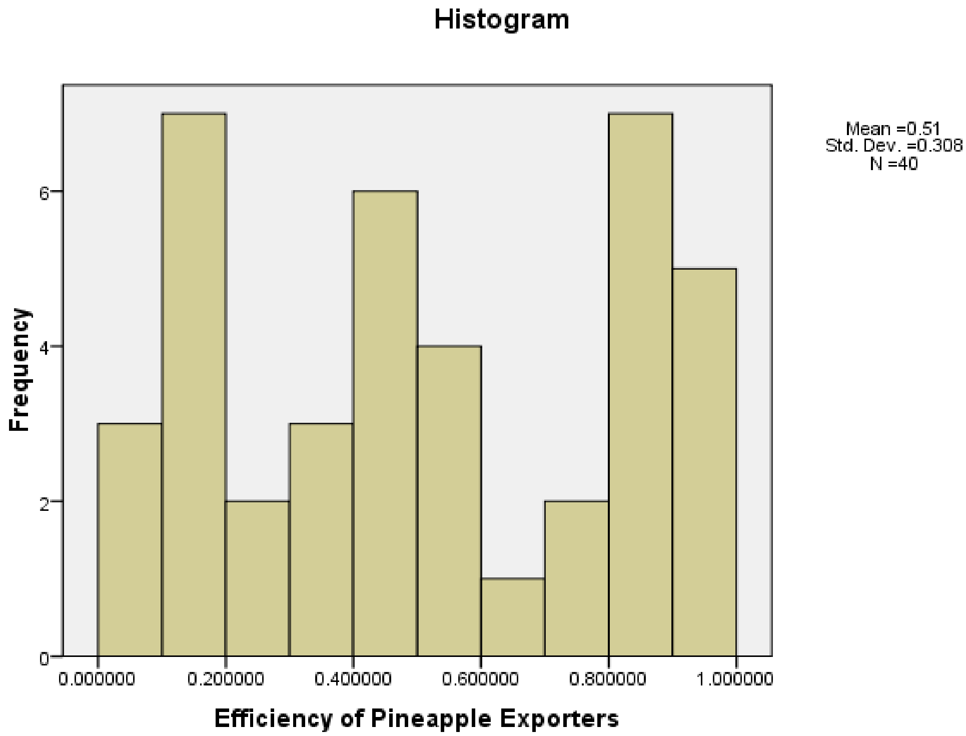
Appendix 2: Predicted Technical Efficiencies of Non Export Pineapple Farms

Farmers Number	Technical Efficiency	Farmers Number	Technical Efficiency
1.	0.898545	41.	0.823359
2.	0.786756	42.	0.590628
3.	0.889291	43.	0.63714
4.	0.986506	44.	0.254107
5.	0.369349	45.	0.482492
6.	0.892562	46.	0.20927
7.	0.436394	47.	0.474844
8.	0.89414	48.	0.596313
9.	0.797428	49.	0.818312
10.	0.83745	50.	0.934577
11.	0.484564	51.	0.675665
12.	0.818712	52.	0.580797
13.	0.858084	53.	0.436508
14.	0.904394	54.	0.164791
15.	0.565134	55.	0.347406
16.	0.758391	56.	0.196462
17.	0.870268	57.	0.206305
18.	0.596419	58.	0.397167
19.	0.560686	59.	0.092782

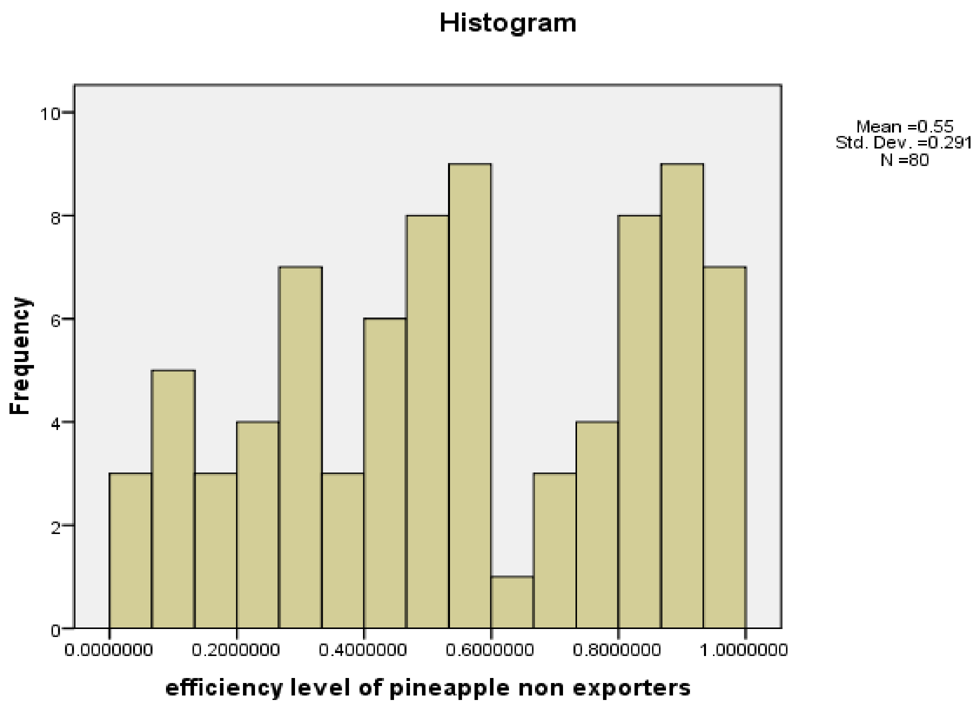
20.	0.724089	60.	0.968555
21.	0.490741	61.	0.285074
22.	0.809928	62.	0.986355
23.	0.018799	63.	0.199886
24.	0.879673	64.	0.238135
25.	0.963913	65.	0.520629
26.	0.757523	66.	0.572495
27.	0.563494	67.	0.040611
28.	0.28858	68.	0.284604
29.	0.06748	69.	0.437394
30.	0.539382	70.	0.975668
31.	0.285205	71.	0.994978
32.	0.088918	72.	0.507712
33.	0.427373	73.	0.298738
34.	0.68281	74.	0.088573
35.	0.92312	75.	0.014487
36.	0.516588	76.	0.51663
37.	0.086347	77.	0.449074
38.	0.927592	78.	0.287094
39.	0.836042	79.	0.267497
40.	0.843095	80.	0.420431

Mean Technical Efficiency = 0.552

Appendix 3: A Histogram Showing the Range of Technical Efficiencies of Pineapple Exporters



Appendix 4: A Histogram Showing the Range of Technical Efficiencies of Non Export Pineapple Farmers



Appendix 5: Correlation Matrix for the logarithm of Output and Variables Affecting Output of Pineapple Exporters

	lnQ	ln X_1	ln X_2	ln X_3	ln X_4	ln X_5
lnQ	1.0000					
ln X_1	0.2831	1.0000				
ln X_2	-0.1052	0.4012	1.0000			
ln X_3	-0.3332	0.4135	-0.2070	1.0000		
ln X_4	-0.3011	-0.1065	0.0215	0.3112	1.0000	
ln X_5	-0.2859	-0.0390	-0.3012	-0.0236	-0.0300	1.0000

Source: Field Survey Data, 2009.

Appendix 6: Correlation Matrix for the logarithm of Output and Variables Affecting Output of Pineapple Non Exporters

	lnQ	lnW_1	lnW_2	lnW_3	lnW_4	lnW_5
lnQ	1.0000					
lnW_1	-0.0192	1.0000				
lnW_2	0.2212	0.4341	1.0000			
lnW_3	-0.3110	0.0423	0.4421	1.0000		
lnW_4	-0.1355	0.3670	-0.2133	0.3320	1.0000	
lnW_5	-0.0270	0.2455	-0.0155	-0.3623	0.2910	1.0000

Source: Field Survey Data, 2009.