Economics of Sugarcane (*Rake*) Production in Mubi Region Adamawa state, Nigeria

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DECLARATION

This research work titled "Economics of Sugarcane (Rake) Production in Mubi Region Adamawa State, Nigeria" was carried out by DANIEL, James Dzarma (M.Sc./AE/07/0090) and being my original work and has been approved as meeting the requirements of school of post graduate studies, Federal University of Technology Yola.

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CERTIFICATION

This is to certify that this thesis Titled "Economics of Sugarcane (RAKE) Production in Mubi Region Adamawa State, Nigeria" has been carried out and duly presented by DANIEL, James Dzarma (M.Sc./AE/07/0090) of the Department of Agricultural Economics and Extension, Federal University of Technology Yola, and has been approved by panel of examiners for the award of Master of Science (M.Sc.) degree in Agricultural Economics.

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ABSTRACT

The study examined the economics of sugarcane production in Mubi Region of Adamawa State, Nigeria. The objectives of the study were to describe the socio-economic characteristics of the farmers, estimate cost and returns associated with sugarcane production, determine the technical efficiency of sugarcane farmers, analyse the influence of some socio-economic variables on their technical efficiency and examine the constraints militating against sugarcane production in the study area. Data used for the study were collected from 160 farmers in three local government areas with the aid of structured questionnaires using purposive and simple random sampling techniques at

various stages. The data collected were analysed using descriptive statistics, budgeting techniques and stochastic frontier production function. The results revealed that 72% of the farmers were youths and 98% were male with most of them (94%) married, also 61% having attained some form of formal education. The computed cost and returns for gross margin and net farm income were ₦111, 762.00 and ₦101, 736.00 per hectare respectively. The result of the stochastic frontier production function analysis showed the coefficients of land, fertiliser and fuelling were significant at ($p < 0.01$) while seed cane was significant at ($P < 0.05$). The mean efficiency was 0.87 while the maximum and minimum were 0.97 and 0.12 respectively. Major problems identified were pest and diseases, high cost of labour, high cost of water pumping machine and poor price. Policy recommendations were directed towards adequate labour-saving technologies, such as tractor hiring services, integrated pests' control, and access to subsidised farm inputs.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Despite the prominent role of the petroleum sector in the Nigerian economy, agriculture remains the main stay of the national economy. It contributes the largest employer of labour and critical contributor to wealth creation and poverty alleviation, about 70% of the population derives its income from agriculture and related activities (Idumajogwu, 2005).

In modern agriculture, sugarcane has been identified as one of the most important commercial crops grown over 74 countries of the world, approximately half of the globe (Aikulola, 1978). The major producing countries of the world are Brazil, India, China, Pakistan, Colombia, Thailand, Mexico and Egypt. Others are South Africa, Cuba, USA and European Union (Simon, 1996; Busari, 2004). These countries are said to account for half of the world sugar supply. Globally, the world sugar production in 2004/2005 was 140.7 million tonnes and the world export in the same year was 47.8 million tonnes (Tyler, 2008).

Brazil is the world largest producer of sugarcane. The real boom in bio fuel production from sugarcane in the country has brought economic success story and a great challenge to the Organisation of Petroleum Exporting Countries (OPEC) as rival market has been created. Out of the expected 17.2

billion gallons (68.8 billion litres) of world ethanol production by 2012, Brazil alone is expected to produce 40% (6.88 billion gallons); currently the country export 2.4 billion litres (600 million gallons) primarily to United States, Japan, South Korea and Sweden (Whelan, 2004). Similarly, India has high prospect in the sugarcane industry, available report indicate that the country has put 2 – 2.7 million hectares about 1.8% of the arable land under sugarcane with annual production of 4.26 million tonnes of sugar annually (Anon, 2004). The role of sugarcane industry in the economic development of Pakistan and Iran has also been stressed. Recent studies revealed that the one million hectares of sugarcane plantation in Pakistan supply raw material to 77 factories besides indigenous brown sugar cottage industries. Also Iran's one million tonnes of annual output of sugar supply 50% of the country's domestic requirements. Furthermore, the country's 5th and 6th developmental plan is that by 2021, the country is expected to produce 11.6 million tonnes of sugar and 1.6 million tonnes of bye-product by cultivating 106,000 hectares (Anon, 2008).

In Africa only few countries are committed to the success story of sugarcane industry. South Africa is said to be the 13th largest producer of sugarcane in the world. The country has 47,000 registered sugarcane growers producing an average of 22 million tonnes of sugarcane annually. Furthermore, South Africa is expected to produce 7.3 billion litres of bio fuel (ethanol) in the next 10 – 15 years (Morris, 2008). In the same vein, Austrey *et al.,* (2006) asserted that in Mauritius the sugarcane industry accounted for 19% of the value

of exports and 5% of the country's Gross Domestic Product (GDP) in 2004. More so, about 90% of the arable land and 45% of total area of the island is devoted to growing of sugarcane. According to Tyler (2008) Zimbabwe has been regarded among the lowest cost sugar producers in the world after Brazil. Before the seizure of the land in the country in 2002 production of sugar reached 600,000 tonnes from 45,000ha annually.

The Nigerian sugarcane industry is not a success story; the sub-sector is largely underdeveloped with untapped resources and potentials. The two major integrated sugar plants at Bacita [Nigerian Sugar Company (NISUCO)] and Numan [(Savannah Sugar Company Limited (SSCL)] was established in 1961 and 1977 respectively with an installed combined capacity of 105,000 tonnes per annum, or about 10% of the country's annual requirement of sugar. However, production has oscillated around 50,000 tonnes annually which is less than 5% of the country's demand (Anon, 2003). The sugarcane production in Nigeria is wide spread and majority of the producers are local farmers' for chewing and local products such as "*masarkwaila*" and "*alewa*". As reported by Akobundu (1987) that out of the 25 – 30,000ha of land under sugarcane production in the country only about 12,000ha are under industrial cane while the bulk is under small scale farmers.

The Savannah Sugar Company Limited (SSCL) Numan is located in Adamawa State but apart from maybe the surrounding communities, farmers of sugarcane in the state have not yet felt the impact of the company as expected.

The main feature of sugarcane production in Nigeria therefore is that bulk of the production is in the hands of peasant farmers on small scale with inadequate irrigation facilities using simple tools for cultivation and inadequate extension services while the demand for sugar and sugarcane products are always on the increase.

1.2 Statement of Problem

In order to accelerate sugarcane production, the Federal Government of Nigeria in 1993 established the National Sugar Development Council, (NSDC) by Decree No.88 and through this council; the government was directly involved in the investment of sugarcane industry. The council gradually set up a target that by 2010 the country might have reached 70% of the sugar requirement (Anon, 2003). In a similar effort, the National Cereals Research Institute (NCRI) developed a 10 tonnes Cane Per day (TCD) mini plant for cottage brown sugar industries to complement the effort of the large scale plants which is cheaper to establish in cane growing communities (Wada *et al.,* 2006).

With all the efforts of the government above therefore, the demand and supply gap still continue to grow wider and wider. The combined production figures of the two major companies at Bacita and Numan stands at less than 1% of the country's demand over the past five years (Wada *et al*., 2006). Meanwhile, sugar dependent industries have sprung up in their thousands within the same period. Consequently, there has been mass importation of sugar at the expense of our foreign exchange which is a national drain to the economy. It is

noted also that a bulk of the sugarcane growers in the country are local farmers on small scale, that is, on 0.2 – 0.5ha for chewing (Anon, 1997). Majority of these farmers use simple tools for the cane cultivation and have little resources that are competitive among other crops, coupled with inadequate technology for sugarcane production which has resulted to low output.

Several factors have been identified as being responsible for the deteriorable state of sugarcane industry in Nigeria. These are poor management, high cost of labour, inadequate spare parts and inadequate input supply. Others are lack of technical knowhow, foreign competition, insufficient irrigation water and low price of sugar (Alison, 1980; Mirchaulum and Eguda, 1995). Similarly, the high cost of developing irrigated cane fields has been stressed. It has been reported that a hectare of land cost about US$10,000 or ₦1.5m/ha at ₦150.00/$1 (Tyler, 2008).

In view of these problems therefore, it is important to carry out a research on the economics of sugarcane production. The study has attempted to answer the following questions:

i. What are the socio economic characteristics of the farmers?
ii. Is sugarcane production a profitable venture in the study area?
iii. What is the level of efficiency of inputs utilisation of the farmers?
iv. What is the relationship between farmers' socio-economic variables and technical efficiency in the study area?

v. What are the constraints militating against sugarcane production in the study area?

1.3 Objectives of the Study

The broad objective of the study is to carry out an economic analysis of sugarcane production in the north-eastern part of Adamawa State. The specific objectives are:

i. to examine the socio-economic characteristics of the sugarcane farmers in the study area;

ii. to determine the cost and returns of sugarcane production among the farmers;

iii. to determine the technical efficiency of resource use among the sugarcane farmers in the study area;

iv. to analyse the influence of socio-economic variables on technical efficiency of the farmers; and

v. to identify problems militating against sugarcane production in the area.

1.4 Significance of the Study

Sugar is an essential commodity. It is an important food item that is used daily in most homes. Its demand in many industries is on the increase on daily bases. Apart from the ethanol which is now a substitute to gasoline, the bye-products such as molasses and bagasse are important in the livestock industry. Preston (2008) asserted that molasses are rich in minerals and organic acids

which are essential for animal nutrition. The local production of the crop for chewing and for local product "*masarkwaila*" has been source of income to the growing communities.

In view of the above therefore, it is important to carry out a research on the economics of sugarcane production in the sense that when completed, it would be useful to the sugarcane farmers for efficient allocation of their meagre resources among competitive crops. It will also help them to take rational decision for selection of farm enterprises. The research will be useful to policy makers, in government and non-governmental organisations, as well as individuals or institutions wishing to carryout similar research in future.

1.5 Scope and Limitation of the Study

The study was limited to zone one of Adamawa State Agricultural Development Programme (ADADP) also known as Mubi Region. It comprises of five Local Government Areas which include Maiha, Mubi South, Mubi North, Michika and Madagali.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin, Distribution and Production Trend of Sugarcane

Sugarcane (*Saccharum Spp*) is said to have become established as a domestic garden crop around 8000BC by Neolithic horticulturalists in what is now New Guinea, and from there it was carried to China, India and eastern Pacific Islands. It was introduced to Morocco in Africa by the Arabs. The crop is widely grown in the tropics and sub-tropics, cultivated in about 74 countries between 40^{o}N and 32.5^{o}S encompassing approximately half of the globe. Modern sugarcane production began when *Saccharum officinarum* 'noble cane' which originated in New Guinea and reaching Tahiti in 1768 replaced *Saccharum barberi* (Fauccionier, 1993; Aikulola, 1978).

According to Naidu, (1987) the crop was introduced to Nigeria by European sailors in the fifteen century along the western coasts. It was initially grown for chewing and livestock feed. When it was noticed that the crop required a relatively higher amount of water to grow well, its cultivation spread into islands and swamp patches of flood plains. Oguntoyinbo, (1978) opined that over the years the crop had adapted itself to variety of soils and climatic conditions such that it is now grown widely across Nigeria; but commercial sugarcane production in Nigeria started in the late 50s. It is of interest that not only sugar can be produced from sugarcane but ethanol which can substitute for gasoline.

Globally, the world sugar output has been on the increase, ISO, (2000) reported that in the past 20 years there has been increase in the output of sugar due to mainly advances in sugar technology in the major producing countries. Furthermore, the report showed that world output of sugar in 2000 was 130 million tonnes which was slightly down by about 6.6 million tonnes against 1999 which was 136.6 million tonnes. The assertion made by Tyler (2008) revealed an increase in the output of sugar. It was reported that in 2004/2005 about 140.7 million tonnes of sugar was globally produced. The report stressed that out of the figure, Africa's output was 8.2 million tonnes while the continent imported 6.6 million tonnes of sugar and export only 3.8 million tonnes indicating that Africa is a net importer of sugar.

In Nigeria, the sugarcane industry is still in an infant stage. The land put under sugarcane has been estimated to be 25 – 35,000ha out of which only 12,000ha are under industrial cane production by the four cane estates at Bacita (6,000ha), Numan (5,000ha), Sunti (500ha) and Lafiagi (300ha). A bulk of land area (hectarages) is under small scale farmers on land area whose range is from 0.2 – 2.0ha grown for chewing locally (Busari, 2004). The recent survey conducted by national Sugar Council has revealed Nigeria's potential and hopes in the sugarcane industry. According to Bichi (2008) 500,000 hectares of land suitable for sugarcane cultivation exist in about 40 different locations which are capable of producing 30 million tonnes of sugarcane or about 3 million tonnes of sugar which will make Nigeria an exporter of the commodity.

The Nigeria's sugar production therefore has been oscillating between 40 – 60,000 tonnes annually which are far below local demand, that is, less than 1% (Tyler, 2008; Wada *et al.*, 2006).

The Savannah Sugar Company at Numan which is located in Adamawa State over the years has been involving the surrounding communities in the "out grower" programme. These farmers have been discouraged due to some challenges such as pests and diseases attack, loss of weight during weighing due to late harvesting after dry off period. In 2000 it was reported that the farmers lost 7.66 tonnes per hectare from the average of 32.91 tonnes/ha yield of the out growers (Abubakar, 2002). In the northeast of Adamawa State farmers are often seen growing their sugarcane along fadama and flood plain of streams which are later harvested and sold for chewing in the villages and towns around and transported in trucks to nearby states like Yobe and Borno.

2.2 Importance of Sugarcane

Sugar, one of the major products of sugarcane processing is an essential commodity, an important food item, a critical raw material in food, beverages and pharmaceutical industries. The by-product of the crop also has enormous potentials. Generally, the plant account for 62% of world sugar supply while sugar beet supply the remaining 38% (Naidu, 1987; Fry, 1997). In developing countries like Nigeria, sugarcane production has been a source of immediate income to many rural communities.

The many uses of coarse white granulated sugar, cube and brown sugar as well as chewing of the cane itself are sufficiently well known in the tropical villages of Africa. The by-product such as molasses has numerous uses; it is used as fertiliser because of the high potash content, used in the manufacture of ginger bread, alcohol and acetic acid. Other uses include manufacture of acetonebetanol, lactic acid, nitric acid, food yeasts, glycerine and glutamine acid (Raemaeker, 2001). Furthermore, the baggasse is used either directly or indirectly as fuel and source of power to the sugar factory. It is also used for making paper pulp, wrapping paper and cardboard.

In modern agriculture, the sugarcane industry is contributing immensely to the economic development of particularly technologically advanced nations such as Brazil, India, and USA etc. Mthimkhelu (2007) opined that in South Africa, sugarcane industry contributes more than R6 billion ($852 million) annually to the economy and provide job to over 350,000 people. Also to ensure sustainability of the role played by the sugar industry in the country, Kwazulu-Natal Department of Agriculture and Environmental Affairs (DAEA) have given R50 million ($7 million) to 30 sugar projects as support to encourage their operations. In a related development Autery *et al.,* (2006) have reported that in 2004 19% of Mauritius export came from sugar industry and also 5% of the country's Gross Domestic Products (GDP). Ninety percent of the arable land and 45% of the total area of Islands are devoted to growing of

sugarcane; as well as provide direct employment to 60,000 workers and small planters.

The resurgence of ethanol, a substitute of gasoline from major sugarcane producing countries like Brazil, China etc is a signal of concern to the oil producing countries like Nigeria. According to Whelan (2004) out of the 390 million tonnes of sugarcane produced annually in Brazil ethanol soaks almost half of the quantity. Brazil alone exported 2.4 billion litres (600 million gallons) of ethanol in 2008 primarily to India, USA, South Korea, Japan and Sweden. The report also revealed that in October 2008, the Brazilian jet maker Embraer announced the first mass produced plane to be powered by ethanol. Experts have been quoted as saying "Brazil the world 5th largest country is uniquely positioned to fuel boom in ethanol as an alternative to gasoline" (Whelan, 2004). In a similar vein the Colombian Government Produces 1.05 million litres of ethanol daily which covers 70% of the country's domestic needs. The government also announces that additional sugar plants have been established capable of producing 400,000 litres of ethanol per day and importation of 500,000 litres of ethanol to meet up the local needs and to reduce increased gasoline prices (Anon, 2008).

2.3 Socio-Economic Characteristics of Farmers

The socio-economic characteristics of farmers have been widely considered important in agricultural production studies because of their influence on the farmers output as they affect decision making. According to

Adebayo and Onu (1999) some socio-economic characteristics of farmers which may affect their performance are age, educational level, marital status, land ownership, access to credit facilities etc. To confirm this assertion Adebode (2006) revealed from studies carried out on Home Garden Farmers in Akinyele Local Government Area of Oyo State that 75% of the farmers had formal education and 24% had informal education which according to him has significantly influenced the level of the income generated from the home gardening. He reported that 39% and 58% of the farmers were 20 – 40 years and 41 – 60 years respectively, while only 3% were aged 61 years older. Sixty percent were married, 12% divorced, 8% were single and 20% were widowed.

According to some accounts of studies by Amaza (1999) found out that whereas land, family labour, hired labour and fertiliser are the major factors that influence the output of food crops in Gombe State.Specific factors that comprise of education and contact with extension agents are the significant factors that accounted for observed variation in efficiency among the farmers. Similarly, Awolola (1995) stressed that the level of farmers education is believed to influenced the use of improved technology in agricultural production and hence farmers productivity.

From study of Resource use Efficiency in Cowpea production in the Northeast zone of Adamawa State, Stephen *et al.*, (2006) opined that 71.92% of the farmers were within the age range of 20 – 49 which according to the authors are young able people capable of effective farm operations. The report added

that 52.05% were male while 50.68% had one form of formal education or the other, but 76.03% that is majority of the farmers had no contact with extension agent which shows that they have little or no benefit from extension innovations. In a related development, Osotimehin *et al.*, (1997) observed that 70% of the homestead farming respondents in a residential area in South-western Nigeria was below 50 years old which according to the report are in their productive years. It was also revealed that majority of respondents 99.26% had formal education may be because of their proximity to Obafemi Awolowo University, Ile-Ife. The regression analysis of the result also revealed that farm size is more significantly determined by the level of education, years of experience in the farming and spouse's income. The argument is similar to that of Adewuyi and Okunmadewa (2001) who said that economic efficiency level of a farmer is significantly being affected by educational level farming experience, extension services available as well as distance of the farm.

2.4 Cost and Returns in Agricultural Production

Cost refers to the value of inputs used in production while profit is obtained by subtracting the cost from the revenue. Farm costs are often divided into fixed and variable costs. Fixed costs are incurred on fixed assets such as building, land, fences and other permanent assets, on the other hand; variable costs are those incurred on assets that can be liquidated examples are cost of fertiliser, animal feeds, labour, drugs etc (Adegeye and Dittoh 1985; Olukosi and Erhabor, 1988). In whichever form the cost incurred with the hope of

driving some benefit from the action taken. A rational decision assumed to choose an enterprise combination with lower cost and greater profit all things being equal.

According to Spurlock and Gills (1997) variable costs are those that manager controls in the short-run and that will increase production as total planned production is increased.

Sankhayan (1988) asserted that agricultural production function is the principles for allocation of scarce resources (inputs) such as land, labour, capital and management which have alternative uses so as to achieve predefined objectives such as profit maximisation, satisfaction or combination at micro and macro levels. Similarly, Olayide and Heady (1982) observed that agricultural production involves the process of combining inputs resources into organised productive unit under management with ultimate objective to maximise profit, maximise satisfaction, minimise cost or a combination of some or all of the motives of a farm enterprise. Alimi (2000) opined that production is the conversion of inputs into output. It is the use of resources to obtain output and these resources could be aggregated into land, labour, capital and management. In order to achieve optimum production, he said that available resources must be used efficiently.

In agricultural production therefore, the profit obtained depends largely on the cost of inputs used, efficient technology employed and a good market price for the product. As rightly put forward by Idachaba (1984) that the

expansion in maize production in the northern states of Nigeria shows clearly that combination of profitable technology and marketing environment is sufficient to induce small scale farmers to produce more of their products. This argument agree with the findings of Izonubi (1984) where he reported that farmers in Imo State resisted planting yellow maize in 1984 despite the bumper harvest they had in 1983 planting season due to poor marketing arrangement which was experienced. The study of cost and returns therefore help the farmers to determine the viability of their farm business and guide them in enterprises selection.

A study of profitability of yam production was carried out in the northern part of Taraba State by Abubakar *et al.,* (2005). From results of costs and returns determination using budgetary techniques to obtain the farmers profit reported that the average cost per hectare for yam production was ₦58, 232.95 during the cropping season while the gross revenue per hectare was ₦111, 191.95 indicating that farmers made ₦52, 959.00 as gross margin. Furthermore, they stressed that 60.0% of the cost of production was yam seed followed by cost of labour which was 34.99% of the total cost; land rent and fertiliser had 1.23% and 4.31% of the total cost respectively. In the same vein Sani et al (2006) carried out studies on tomato production under pump irrigation in Dawakin-Tofa Area of Kano State to determine the profitability of the farm business. The analysis of the results showed that the farmers incurred ₦122,639.70 as cost per hectare; the revenue generated per hectare was

₦308,819.90, that is, the farmers made a profit of ₦182,179.20/ha. This result showed that tomato production in the study area is highly profitable and prospective farmers can take advantage to invest in it. Similarly, Daniel *et al* (2009a) observed that cotton farmers in the southern part of Adamawa State made net returns of ₦11, 101.08 per hectare.

In another study conducted on cowpea farmers in the north-eastern part of Adamawa State by Stephen *et al.*, (2007) to determine costs and returns from the enterprise as well as benefit cost ratio, to estimate returns on every naira invested. Results obtained showed that cowpea production is profitable with an average gross margin and net farm income of ₦14, 466.26/ha and ₦10, 109.20/ha respectively. The benefit/cost ratio was found to be ₦1.37 which according them revealed a net return of 37 kobo on every naira invested in cowpea production which they said is worth doing than keeping money in savings account in the commercial banks.

Similarly, Mshelia *et al.*, (2005) employed gross and market margin analysis to measure profit obtained from paddy rice processing in Adamawa State. The result of the analysis revealed that the whole sellers who purchased paddy rice, processed and marketed it made a gross margin of ₦19.52/Kg, with a marketing margin of 43.40% and processing cost of ₦7.21/Kg of processed rice. Also gross margin for retailers of processed paddy rice was ₦7.41/Kg of processed rice. Furthermore, the analysis revealed that for every naira invested by the wholesalers on paddy rice processing yielded 40 kobo as gross margin

which was higher than retailers who had 13 kobo as returns on naira invested. Investment returns are therefore higher with wholesalers of processed paddy than with the retailers.

In another separate study, Ugwu (2006) worked out an enterprise budget to ascertain the viability of smallholder pig farmers in Enugu State. The results showed that the farmers made a profit of ₦102, 819.54 per annum per average farmer; he concluded that pig production in Enugu State is a profitable livestock enterprise. In a related development Okeke (2007) found out that cattle marketers in Jos metropolis of Plateau State had ₦46, 000.00 as profit margin per month. Further analysis revealed that the pricing is in efficient at the market according to him the coefficient is greater as costs constitute a very high percentage of total sales. Some problems reported for traders include lack of basic market infrastructure, inadequate inspection of animals by veterinary authorities, multiple taxes by legal and illegal entities etc.

The author recommends alleviation of these problems to consolidate the growth already achieved in cattle production and marketing in the study area.

2.5 Resource use Efficiency in Agricultural Production

According to Olayide and Heady (1982) agricultural production efficiency is the index of the ratio of the total farm output to the value of total inputs used in the farm production. The analysis of the efficiency is generally associated with the possibility of farms producing at certain optimal level of output from a given bundle of resources or certain level of output at least cost

possible. The greater the ratio or output, the greater the magnitude of technical efficiency and vice versa. Amaza (2000) and Reddy,*etal*;(2008) stressed that productivity is the measure of output per unit of input which is utilized in the relevant production process.

Efficiency has been defined by Upton (1996) as the relative performance of the process used in transferring a given input into output. Furthermore, Amaza and Maurice (2005) as cited by Onoja and Achike (2008) reiterated that technical efficiency in production is the ability of farmer to produce at the maximum output (frontier production), given the quantities of inputs and production technology.

The argument made by Udoh (2000) as cited by Yusuf and Adeneyan (2008) was that efficiency studies is a significant area of research especially in a developing economy like Nigeria where resources are meagre and opportunities for developing and adopting better technology are dwindling. Measurement of efficiency of resource use becomes important for productivity growth. Such studies ascertain the extent to which it is possible to increase productivity by improving efficiency with the present resource base and the available technology. Thus by so doing researchers could resolve whether to improve efficiency first or develop technology in the short run (Yusuf and Adenegan 2008).

In the recent past various studies on technical efficiency of farmers have been carried out across so many communities in Nigeria and majority of their

findings indicated that the farmers are utilizing their resources below frontier level that is below unity (less than 100%). Empirical evidence can be seen from the works of (Shehu, Tashkalma and Gabdo, 2007; Shehu, *etal.*,2007; Yusuf and Adenegan, 2008).

2.6 Types of Economic Efficiencies

There are basically three types of economic efficiencies identified; they are; technical, allocative and economic efficiencies. Amaza and Maurice (2005) defined technical efficiency as the achievement of the maximum potential output (frontier production) from a given quantity of inputs under a given technology. According to Farell (1957) a technically efficient farm operates on the production frontier while technical in efficient operates below production frontier.

Ogundari and Ojo (2006) described allocative efficiency as the ability to choose optimum input levels for a given factor price i.e. when production occurs at a point where the marginal value product equals marginal factor cost. On the other hand economic efficiency has been defined by the authors as the product of technical economic efficiency and the allocative economic efficiency.

2.7 Method of Productivity and Efficiency Measurement

There are four (4) ways through which productivity and efficiency can be measured, Erhabor and Omokaro (2008) mentioned them as follows: -

i. Least squares econometric production models (LSEPM)

ii. Total Factor Productivity Indices (TFPI)

iii. Data Envelopment Analysis (DEA) and

iv. Stochastic Frontier Production Function (SFPF).

The Center for Efficiency and Productivity Analysis (CEPA, 2003), recommended the use of either DEA or SFPF in measuring the efficiency of production due to the inadequacies associated with the use of the LSEPM and TFPI. The DEA is non-parametric requiring the use of linear programming while SFPF is parametric and involves the use of econometric methods. The assumption that the production function of a fully efficient firm is known is not true in practice. So Farell (1957), suggested that it can be estimated from sample data using either parametric or non-parametric function such as Cobb Douglas Form. The parametric form resulted in the development of the stochastic frontier approach (CEPA, 2003). The advantage of SFPF is that it accounts for the "noise" or disturbance problem often encountered in data collection.

Empirical estimates from the results of studies carried out by Erhabor and Emokaro (2008), on cassava farmers in Edo state showed that the farmers in the three ecological zones of the state were not efficient in their use of production resources. The land and planting materials were under utilized in the three zones, labour (both family and hired) was over utilized in Edo South and Central and underutilized in Edo North. This suggests the existence of a reasonable gap in the production technologies of cassava farmers in three

ecological zones. Relevant intervention is therefore needed in the transfer of production technology that would enhance the current level of efficiency of the cassava farmers.

In a similar view, Omotesho *et al.*, (2008) reported that the efficiency of youth participation in agriculture in Ondo state is below frontier production. The estimated minimum efficiency of the youth was 32.62% while maximum efficiency was 96.25% and the mean technical efficiency was 85.23%. This mean value indicates that if input usage is increased by 14.77% the youth will be operating on the production frontier thus, opportunity still exists for increasing productivity and income through increased efficiency in resource utilization. The major factors influencing the technical in efficiency of the youth in the study area are household size, usage of extension services and educational level of the participants. Furthermore, Bologun *et al.*, (2007) observed that in Gwagwalada Kuje Area council, Abuja farmers planting yam/millet mixture made profit. The farm budgeting analysis gave an estimated cost of N75, 850.00/ha while the gross margin was N37, 224.29/ha that is a turnover rate of about 1.4. The report further said that although yam/millet mixture production in the study area is profitable but resources were not efficiently utilized. The scholars recommended improvement in framers utilization of inputs as they are underutilized through organized enlightenment programme particularly the agricultural Development Programme.

In another study by Giroh *et al.,* (2008) on the profitability analysis and technical efficiency of rubber latex production in southern Nigeria, they found out that farmers made a net farm income of N14, 214.11/ha. Analysis of the technical efficiency of farmers from the SFPF revealed that the farmers are operating below production frontier, the average mean of 0.72 or 72%. Fifty six percent of the farmers have their TE below the mean while 44% attained TE above the mean; there was a wide variation in technical efficiency among the farmers which the authors recommended for further investigation.

The work carried out by Ojo and Mohammed (2008) to determine the technical efficiency in peasant sorghum production in Niger state unveiled that the mean technical efficiency of the farmers was 63.2%. The empirical estimation of technical efficiency of the peasants using stochastic frontier function showed that technical efficiency varies among the farmers due to the presence of technical in efficiency effects in sorghum production. The distribution of the technical efficiency indices revealed that most of the farmers are moderately technical efficient with about 57% of the farmers have technical efficiency of above 60%.

2.8 Constraints of Sugarcane Production

Several factors have been identified as constraints responsible for the poor state of sugarcane industry in Nigeria. According to Wada (1997); Busari (2004) the sugarcane industry in Nigeria is still in an infancy stage in terms of size and technological status. They pointed out that a smut disease caused by a

pathogen *Ustilago scitaminea Syd* alone is a major limiting production of both industrial and chewing sugarcane in Nigeria. The disease has been reported to be responsible for wiping out susceptible cane varieties in many countries.

The study carried out by Abubakar (2002) on sugarcane "out growers" under Savannah Sugar Company at Numan Adamawa State; reported pest and diseases as problems of the farmers that reduce their yield. He said the major pests are stem borers ground beetle and termites while the common diseases include smut and streak.

The work of Mirchaulum and Eguda (1995) has revealed more factors that are constraints to our local sugar companies. These problems as they were mention include high cost of labour, inadequate spare parts, inadequate inputs and technical problems. Others are financial, poor management and foreign competition. Similarly, Alison (1980) reported that the problem of sugar industry in Nigeria is not unconnected with lack of cane varieties that can stand the test of time, high cost of labour, insufficient irrigation water and low price of sugar.

Generally, sugarcane cultivation and the establishment of the sugar factories are capital intensive. The National Sugar Council of Nigeria (NSC 2003) reported that inadequate capital to meet up the current and capital expenditure as well as to go for new investment in the sugarcane industry is a limiting factor. As also asserted by Tyler (2008) that in Africa the land development for irrigated cane fields cost up to US $10,000/ha which is about

₦1.5 million equivalents while factory establishment can cost up to US $100m about ₦15 billion equivalent at ₦150.00/dollar.

In summary, the cultivation and processing of the crop is capital intensive, the desired technologies are not yet properly in place. Also farmers are faced with challenges such as pest and diseases, inadequate and high cost of inputs, insufficient irrigation water, inadequate and high cost of tractors when available, mismanagement etc. This particular study will also focus on problems of the farmers in the study area with intention to proffer possible solution in order to improve farmers' productivity.

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

The study was carried out in Adamawa state Agricultural Development Programme zone one (also known as Mubi Region).It lies between latitude 9°30' and 11°45' north of the equator and longitude 13° and 13° 45› east of the Greenwich Meridian (Fig1). It is bounded by Hong and Song Local Government Areas in the west, Borno State in the north and the south and east by the Republic of Cameroon. It has a land mass of 4,728.77Km^2 and a population of 681,353 (Adebayo, 2004; NPC, 2007).

The mean annual temperature of the zone is 32.86°c, while the mean annual rainfall ranges from 900mm to 1,050mm with a distinct dry season which begins in October and ends in April while the wet season begins in May and ends in September or sometimes in October. The zone is also located within the Sudan Savannah belt of the Nigeria's vegetation zones (Adebayo, 2004).

The major economic activity in the zone is agriculture. Food crops grown in the area are maize, sorghum, cowpea, rice, cassava, sweet potato etc while cash crops include groundnut, sugarcane, Beniseed, cotton and so on. Major livestock reared in the zone are cattle, sheep and goats.

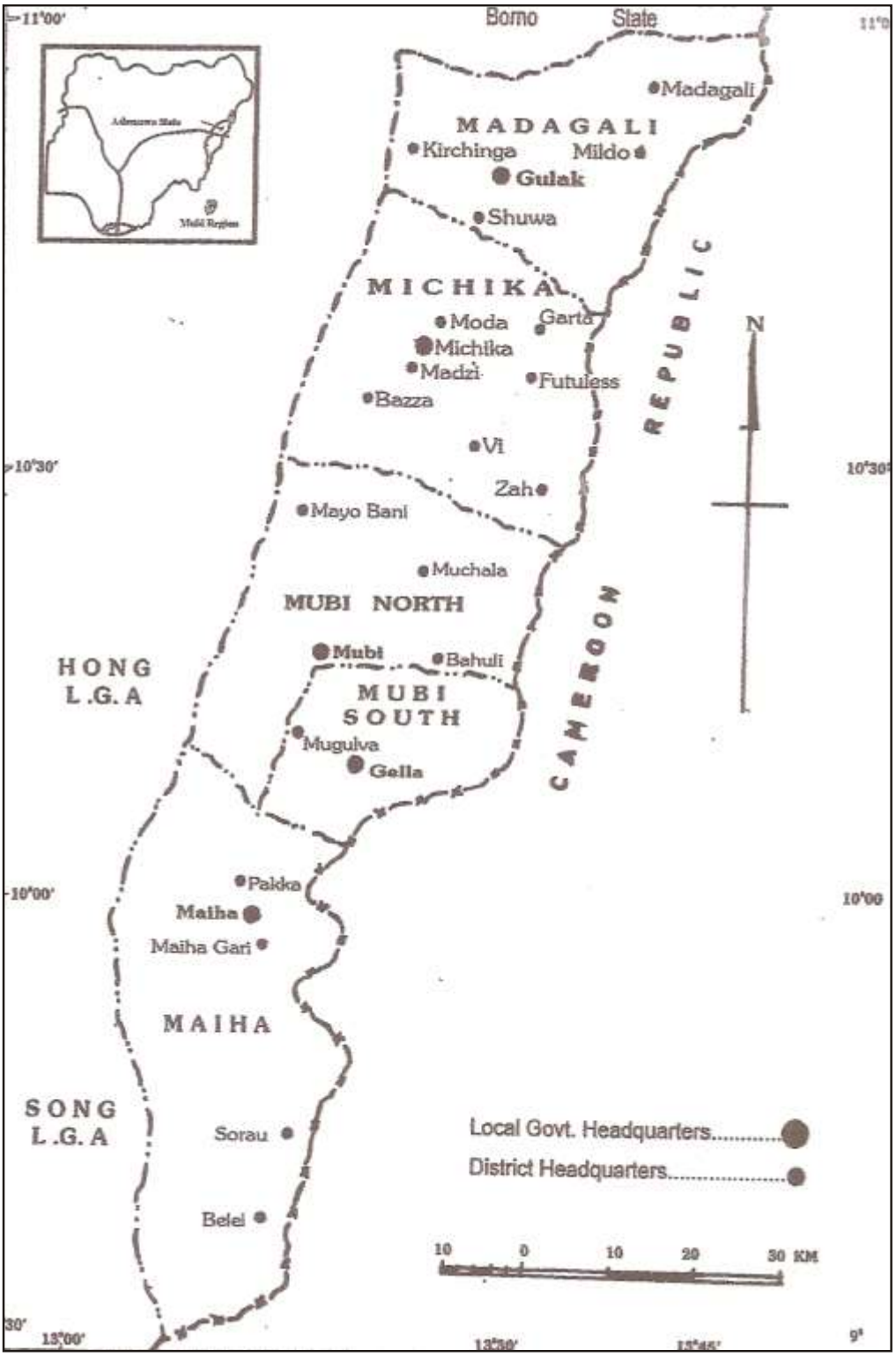

Fig 1 Map showing the study area

3.2 Source of Data

The main source of data for this study was primary. This was sourced directly from the respondents through administration of structured questionnaires.

3.3 Sampling Procedure

Following Uzoagulu (1998), Purposive and simple random sampling techniques were adopted at various stages as the selection procedures of the respondents for the study.The zone is made up of five Local Government Areas which include Maiha, Mubi South, Mubi North, Michika and Madagali.In the first stage, out of the five local government areas, three were randomly selected, and these were Mubi North, Maiha and Madagali. In stage two selection of the cells under each block in the selected local government areas was purposive because preliminary survey revealed that most of the sugarcane farmers had accessible streams. In the final stage 180 farmers were randomly selected proportionate to the size of the various cells and were administered with structured questionnaires (Fig 2). The information on respondents regards socio-economic characteristics, farming activities, cost and returns for the 2008/2009 cropping season.

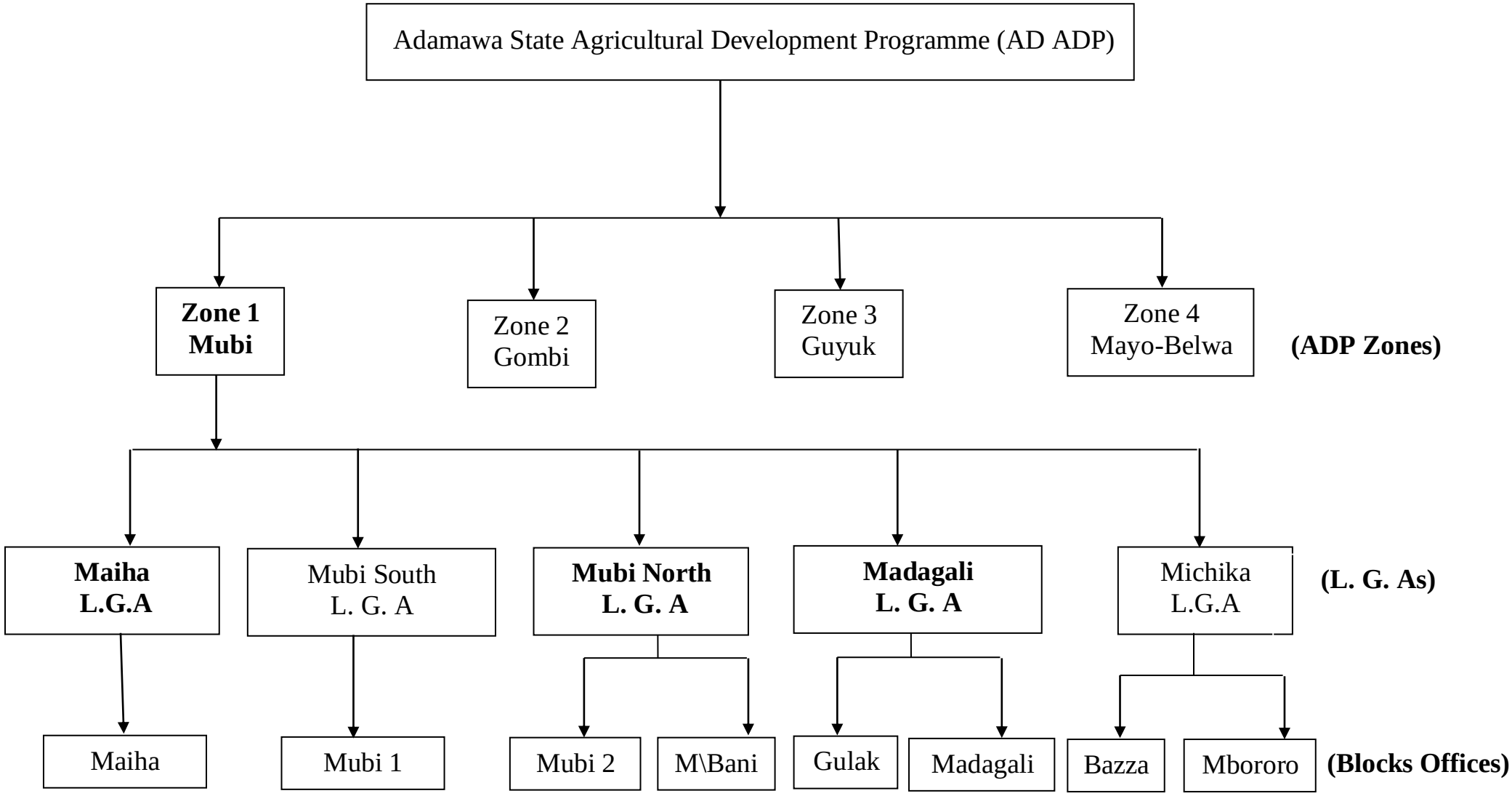

Fig. 3.2 Flowchart showing stages of the sampling procedures.

3.4 Methods of Data Analysis

The analytical tools used to achieve the objectives of the study were descriptive statistic, profitability analysis (budgeting techniques) and Stochastic Frontier Production Function (SFPF).

3.4.1 Descriptive Statistics

This was used to achieve objectives 1 and 5. These include the use of frequency counts, means and percentage.

3.4.2 Profitability Analysis

According Olukosi and Erhabor (1988) farm budget is a detailed physical and financial plan for farm operation for a certain period. The profitability analysis was used to estimate total costs and total receipts (revenue or returns) within the production period. The profit level as measured by Alabi and Adebayo (2008) is specified as:

$$GM = GFI - TVC \quad \ldots\ldots (1)$$

$$NFI = TGM - TFC \text{--------} (2)$$

Where:

GM = Gross Margin (₦ /ha)

GFI = Gross Farm Income (₦)

TVC = Total Variable Cost (₦/ha)

TFC = Total Fixed Cost (₦ /ha)

NFI = Net Farm Income (₦ /ha)

TGM = Total Gross Margin (₦)

3.4.3 Gross Ratio

This is a measure of profitability ratio that give over all success of the farm. The lower the ratio the higher the returns per naira. Olukosi *etal.* (2008) compute the ratio as given below;

GR=TFE/GI

Where GR= Gross ratio

TFE=Total farm expense, GI= Gross farm income

3.4.4 Operating Ratio

Operating ratio is directly related to the farm variable inputs usage Olukosi *etal*, (2008) stated that a ratio of one reveals break even. The lower the ratio greater the profitability of the farm business. The ratio is computed thus;

OR=TOC/GI

Where OR=Operating ratio

TOC=Total operating cost

GI=Gross income

3.4.5 Return on Capital Investment

According to Nasiru *etal.* (2006) return on naira invested defined as gross margin divided by total variable cost which can be obtained as;

RI=GM/TVC

Where RI=Return on capital invested

GM=Gross margin

TVC=Total variable cost

This model will be employed to achieve objective 2

3.4.6 Stochastic Frontier Production Function

Another tool used for the analysis was the stochastic frontier production function model following Battese and Coelli (1995) as cited by Omotesho *et al.*, (2008). The model is specified as follows:

$$Y_i = f(X_i, \beta) + (V_i - U_i) \quad \ldots\ldots\ldots (3)$$

Where:

Y_i = is the output of the i^{th} farm

X_i = is a vector of input quantities of the i^{th} farm.

β = is a vector of unknown parameters to be estimated

V_i = are random variables which are assumed to be normally distributed N (O, δ2V) and independent of U_i. Is assumed to account for measurement errors, and other factors beyond farmers' control.

U_i = these are non-negative random variables called technical inefficiency effects which are assumed to be half normally distributed N(O,δ^2U). (Erhabor and Emokaro, 2008).

A Cobb – Douglas Stochastic Production Frontier Model was used for this study and presented as follows:

$$LnY = \beta_o + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + \beta_6 LnX_6 + \beta_7 LnX_7 + V_i - U_i \quad \ldots\ldots\ldots (4)$$

Where:

Y = Output of sugarcane (Kg)

X_1 = Size of the farm (hectares)

X_2 = Planting materials (kg).

X_3 = Hired labour (man-days).

X_4 = Family labour (man-days).

X_5 = Pesticides used (liters).

X_6 = Amount of fertilizer used (kg).

X_7 = Amount of fuel consumed (liters)

β_o, $\beta_1 - \beta_7$ = parameters to be estimated

$V_i = N(O,\delta^2 V)$ as defined above.

$U_i = N(O,\delta^2 U)$ as defined above.

The inefficiency model is represented by U_i which is defined as follows:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \quad \ldots\ldots (5)$$

Where:

U_i = Technical inefficiency

Z_1 = Age (years)

Z_2 = Household size (number)

Z_3 = Farming experience (years)

Z_4 = Number of years of formal education

Z_5 = Extension visit (Dummy, yes =1 no =0)

Z_6= Membership of association (Dummy, yes =1 no = 0)

$\delta_0 - \delta_6$ = parameters to be estimated

The Maximum Likelihood Estimate (MLE) for all parameters of the stochastic frontier production function and inefficiency model defined above as well as the technical efficiency was obtained using frontier 4.1C (Coelli, 1994). Objectives 3 and 4 were achieved through this model.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents results of analysed data. The results presented here are the socio-economic characteristics of the respondents, profitability analysis, and efficiency of the farmers as well as constraints militating against sugarcane production in the study area.

4. 1 Socio-Economic Characteristics of the Farmers

This section discussed the socio-economic characteristics of the farmers such as age, sex, marital status, family size, farm size and so on. These distributions are presented as below:

4.1.1 Age Distribution of the Respondents

As shown in Table 4.1, about 72.49% of the respondents are within the age range of ≤ 20 – 49 years the result which indicated that majority of the farmers are strong people capable of doing the vigorous labour involved in sugarcane farming. About 15.63% were between 55 – 59 years while 11.88% were aged 60 years or older.

Table 4.1: Age Distribution of the Respondents

Age (years)	Frequency	Percentage (%)
≤ 20 – 29	18	11.25
30 – 39	49	30.62
40 – 49	49	30.62
50 – 59	25	15.63
60 and above	19	11.88
Total	160	100.00
Mean 43		

Source: Field survey, 2010.

4.1.2 Gender Distribution of the Respondents

Analyses in Table 4.2 revealed that only 1.88% of the respondents were female while the male counterpart accounted for 98.12% of the farmers. The less participation of women in sugarcane farming in the study area is not unconnected with the hard labour involved as well as capital intensive nature of the crop. The female folks can be encouraged through awareness and financial assistance in form of credit/loan facilities at their disposal.

Table 4.2: Distribution of the Respondents Based on Gender

Gender	Frequency	Percentage (%)
Male	157	98.12
Female	03	1.88
Total	160	100.00

Source: Field survey, 2010.

4.1.3 Marital Status of the Respondents

The marital status of the respondents shown in Table 4.3 unveiled that 93.75% of them were married against 6.25% which constitute the single and widowed. The greater proportion of married people could mean that the crop can yield income that can alleviate family problems as well as source of labour.

Table 4.3: Distribution of Respondents Based on Marital Status

Marital status	Frequency	Percentage (%)
Married	150	93.75
Singled	09	05.63
Widowed	01	00.62
Total	160	100.00

Source: Field survey, 2010.

4.1.4 Distribution of Respondents According to family Size

The family size distribution of the respondents in Table 4.4, shows that 48.75% had 1 – 10 people in their household while more than 50% of them had at least 11 members and above in their household. The large family size of most of the respondents is an indication that some of them may depend on their family for labour.

Table 4.4: Distribution of Respondents according to Family Size

Family size	Frequency	Percentage (%)
1 – 5	30	18.75
6 – 10	48	30.00
11 and above	82	51.25
Total	160	100.00
Mean 10		

Source: Field survey, 2010.

4.1.5 Distribution of Respondents According to Farm Size

The breakdown of the farmers on the basis of farm size revealed that most of the respondents were mainly small scale farmers (85%),who operated on farm size ranging from <1.0 – 2.0ha. Some (14.37%) of the respondents operated on farm size ranging from 2.1 – 5.0ha, with only 0.62% had more than five hectares of sugarcane (Table 4.5). The smaller farm size of the respondents may be attributed to the hard labour involved especially in the peasantry practice coupled with inadequate credit facilities necessary to expand their farm lands.

Table 4.5: Distribution of Respondents Based on Farm Size

Size in (ha)	Frequency	Percentage (%)
<1.0	73	45.63
1.0 – 2.0	63	39.38
2.1 – 3.0	10	06.25
3.1 – 4.0	04	02.50
4.1 – 5.0	09	05.62
5.1 and above	01	0.62
Total	160	100.00
Mean 1.2		

Source: Field survey, 2010.

4.1.6 Distribution of Respondents According to Literacy

The level of literacy of the farmers showed that more than 61% had one form of formal education or the other; however 39% of the respondents did not receive any form of formal education (Table 4.6). The importance of education in economic development has been stressed by Ndanitsa (2008) who observed that education determines the quality of skills of the farmer, his allocative abilities and show how well informed he is of the innovations and technology around him.

Table 4.6: Distribution of Respondents According to their Literacy Level.

Level of literacy	Frequency	Percentage (%)
No formal Education	62	38.75
Primary Education	43	26.87
Secondary Education	45	28.13
Tertiary	10	06.25
Total	160	100.00

Source: Field survey, 2010.

4.1.7 Distribution of Respondents According to Land acquisition

As observed by Adebayo and Onu (1999) that land ownership is one of the socio-economic characteristics of farmers which affect their productivity. Analysis of Table 4.7 above has shown that majority of the farmers (66.25%) operated on inherited farmlands while 13.13% had their own on purchased. Further, about 20.62% hired their farmlands for sugarcane. While the inherited and purchased land owners may have a long term plan on their farms the persons that hired may find it difficult because they may suffer disappointment from land owners.

Table 4.7 Distribution of Respondents Based on Land Acquisition Method.

Land acquisition method	Frequency	Percentage (%)
Hired	33	20.62
Purchased	21	13.13
Inherited	106	66.25
Total	160	100.00

Source: Field survey, 2010.

4.1.8 Distribution of Respondents Based on Farming Experience

Farming experience of the farmers as shown in Table 4.8 indicated that 89.50% of them have been in the farming business for at least 6 years to more than 15 years. Only few of the farmers (17.5%) had 1 to 5 years as experience in sugarcane cultivation. These farmers are experienced which could positively influence their management capabilities of the crop. As reported by Adewumi and Okunmadewa (2001) that the economic efficiency level of farmers significantly affect their farming experience.

Table 4.8: Distribution of Respondents According to Experience

Experience (years)	Frequency	Percentage (%)
1 – 5	28	17.50
6 – 10	49	30.63
11 – 15	22	13.75
Above 15	61	38.12
Total	160	100.00
Mean 24		

Source: Field survey, 2010.

4.1.9 Distribution of Respondents According to source of Labour

Table 4.9 shows that 85.0% of the respondents depended on hired labour a few (6.87%) used family labour for the period under review, while 8.13% employed both hired and family labour for management of their cane fields. The less dependent on family labour may attribute to hard labour required at some stages of sugarcane production which children and women may not perform very well. Most farmers along River klanyi flood plain in Maiha LGA complained of inadequate and high cost of labour as a limiting factor to expanded farms. According Ntare (2005) one of the major limiting factors of groundnut production is the high cost of labour.

Table 4.9: Distribution of Respondents Based on Sources of Labour

Sources of labour	Frequency	Percentage (%)
Family	11	06.87
Hired	136	85.00
Both	13	08.13
Total	160	100.00

Source: Field survey, 2010.

4.1.10 Distribution of the Respondents According to Source of Finance

The findings in Table 4.10 indicated that 95.62% of the farmers depended on personal savings for their capital base while 3.75% depended on informal sources. This report is similar to that of Stephen (2006) who carried out studies on cowpea farmers within the same study area and found out that 96.58% of the farmers depended on personal savings, a clear indication that the farmers have little or no access to institutions that give out loan/credit facilities.

Table 4.10: Distribution of Respondents Based on Sources of Finance

Sources of finance	Frequency	Percentage (%)
Personal savings	153	95.62
Borrowed from banks	01	0.63
Borrowed from Friends/ Relations	06	03.75
Total	160	100.00

Source: Field survey, 2010.

4.1.11 Distribution of Respondents According to Market Location for Produce

More than half of the respondents (58.75%) depended on urban market for the sale of their farm produce, 23.12% of them patronised both rural and urban markets to sale their produce. A smaller proportion of the farmers that is12.50% reported that their cane fields were sold on the field direct to dealers or middlemen (Table 4.11).

Table 4.11: Distribution of Respondents Based on Market Location for Farm Produce

Market/location	Frequency	Percentage (%)
Rural Market	09	05.63
Urban	94	58.75
Both	37	23.12
Direct sales to dealers	20	12.50
Total	160	100.00

Source: Field survey, 2010.

4.1.12 Distribution of Respondents Based on Extension Contact

Despite the role of extension education in agricultural transformation through the extension agents who can simplify research results into languages and simple demonstrations which the farm families can understand and use, analysis on Table 4.12 revealed that 47.50% of the farmers have no contact with

extension workers in their domain. Some 43.75% stressed that extension agents come in contact with them on request or occasionally. About 8.12% reported that extension agents visit them fortnightly while 0.63% asserted that his visits were twice a week. These results showed that the farmers in the study area may not be properly in tune with the new innovations in agriculture usually acquired through extension teaching.

Table 4.12: Distribution of Respondents Based on Extension Contact

Visiting schedule	Frequency	Percentage (%)
No Visit	76	47.50
Twice a Week	01	0.63
Fortnight	13	08.12
On Request/Occasionally	70	43.75
Total	160	100.00

Source: Field survey, 2010.

4.1.13 Distribution of the Respondents According to Membership of cooperative Societies

The distribution of respondents in relation to their membership of cooperative societies in Table 4.13 shows that 77.50% of them belong to one cooperative society or the other. Further, some 22.50% of them have not yet identified themselves with any. In the study area one of the visible cooperative societies of the respondents is the Sugarcane Farmers Association in Mubi-

North Local Government Area at Wuro-Gude, through which the sugarcane farmers source for any kind of assistance. Olukosi *et al* (2008) asserted that cooperatives evolve out of felt needs of members who want to solve their common problems by pooling their limited resources together.

Table 4.13: Membership of Cooperative Societies

Responses	Frequency	Percentage (%)
Yes	124	77.50
No	36	22.50
Total	160	100.00

Source: Field survey, 2010.

4.2 Profitability Analysis of Sugarcane Production in the Study Area

From Table 4.14 below the average total cost of the respondents per hectare was ₦278, 660.43, out of which ₦268, 634.24 was variable cost which accounted for 96.40% of total cost. This was largely attributed to the high cost of labour and having converted family labour by costing it at the prevailing market price rate. The fixed cost which was ₦10, 026.19 also accounted for 3.60% of the total cost. The average output of the respondents was 29,261.28kg per hectare while the revenue generated was ₦380, 396.64 per hectare.

Furthermore, the farmers had gross margin and net returns of ₦111, 762.46 and ₦101, 736.27 per hectare respectively. This implied that sugarcane cultivation is profitable venture in the area. These findings tend to agree with that of Daniel *et al.,* (2009b) who carried out similar studies on sugarcane

farmers in the northeast of Adamawa State and reported that farmers made a profit of N115, 153.22 per hectare. More so, the net return on Naira invested (R.O.I.) was 0.37 while the gross ratio (GR) was found to be 0.73; Olukosi and Erahbor (2008) reported that a gross ratio less than 1 is always desirable for farm business. The analysis further gave 0.70 as operating ratio that is 70% of the gross income went for variable cost.

Table 4.14: **Average Costs and Returns per Hectare of Sugarcane Production**

	Production variables	Value (₦/ha)
A	**Variable Costs**	
	Seed cane	71,860.35
	Pesticides	3,376.11
	Fertilizer	19,374.44
	Fueling	14,216.39
	Transportation	45,265.44
	Labour	114,551.52
	TVC	**268,634.24**
B	**Fixed Cost**	
	Depreciation	2,140.87
	Rent on land	7,885.32
	TFC	**10,026.19**
	Total Cost of Production (A + B)	**278,660.43**
C	Returns	
	Average output	29,261.28kg
	Average price ₦/Kg	13.00
	Total Revenue	380,396.64
	Gross Margin (GM)	**111,762.46**
	Net Farm Income (NFI)	101,736.27
	Gross Margin on Naira Invested	0.42
	Net Farm Income on Naira Invested	0.37
	Farm Gross Ratio (GR)	0.73
	Operating Ratio (OR)	0.70

Source: Field survey, 2010.

4.3.1 Results of the Stochastic Frontier Production Function Analysis

An empirical result of the stochastic frontier production function is presented in Table 4.15. In the table are estimates of the parameters for the frontier production function, the inefficiency model and the variance parameters of the model. The variance parameters for the frontier production function are statistically significant at 1% level. The estimate of the sigma squared (0.538) indicates a good fit and correctness of the distributional forms for the composite error term. The variance ratio of gamma (γ) which was associated with the variance of technical inefficiency effects in the stochastic frontier is estimated to be 0.98. This indicated that 98% of total variation in sugarcane output for the farmers was due to differences in Technical Efficiency (TE). This also implies that ordinary least square estimates may not be adequate enough to explain the inefficiency variation among the sugarcane farmers, hence the use of stochastic frontier production function.

Typical of the Cobb-Douglas production function the estimated coefficients of the explanatory variables are their direct elasticities. From the results, four of the variables had the expected positive signs suggesting that more output would be obtained from the use of additional quantities of these variables all things being equal. The coefficients of farm size (0.902), fertiliser (0.019) and fuelling (0.049) have positive signs, and statistically significant at 1% probability, while seed cane (0.036) was also positive and significant at 5% probability. An increase in farm size appears to contribute to the output more

than any of the variables. The coefficient indicates that an increase by 1% of it will lead to the increase of output by 0.902%. The significance of the variable is as a result of its importance in crop production which has direct negative effect on the output in case of shortage or absence. This result is in conformity with the findings of Taphee (2009) who also reported that increase in farm size among groundnut farmers in Northern Taraba State results to increase in output ceteris paribus.

An increase by 1% of the quantities of fuelling, seed and fertiliser will mean increase in the output of the farmers by 0.049%, 0.036% and 0.019 respectively, all things being equal. The significance of fertiliser is not unconnected with the importance of artificial fertiliser which supplements the nutrients requirements of the sugarcane plant. The significance and the positive sign of seed variable indicate that a moderate increase in population of sugarcane on the field will increase yield provided that the farm is not over populated that will lead to competition for nutrients which will lower the yield. These findings are in consonance with the works of Shehu *et al.,* (2007) and Ogundari (2008). The desired (positive) sign and the significance associated with fuelling of water pump also confirms the important role of irrigation water as source of moisture for the sugarcane plant since propagation is done in the dry season, a steady irrigation of the field tend to give better crop establishment and hence a source of better yield.

The coefficients of pesticides (-0.008) family (-0.005) and hired (-1.011) labour are negative and insignificant which is contrary to the apriori expectation signs. The negative effect and the insignificance; of family and hired labour may attribute to over dependence on manual labour as well as over use of the variable factor in the study area common feature of agricultural production in the developing countries like Nigeria. Therefore, a unit increase in labour tends to reduce the output of the sugarcane farmers. Also despite the important role of pesticides in modern agriculture for efficiency and increased output it had negative effect on the farmers output and was not significant. This may attribute to the inability of some farmers in the study area to use the agro-chemicals judiciously as recommended so that the desired results are obtained. Instead increase in the use of the chemicals results in decreased yield. This is similar with the findings of Owa et al (2007), Shehu *et al.*, (2007) and Kwaghe *et a.,l* (2009).

4.3.2 Determinants of Technical Inefficiency

Table 4.15 also presents the coefficients of the inefficiency function which explain levels of technical inefficiency among individual farmers. The sign of the coefficients in the inefficiency model are interpreted in the opposite way such that a negative sign means that the variable increases efficiency and vice versa (Adebayo, 2007). The coefficient of household size (-1.503) had the negative apriori expectation and is statistically significant and different from zero at 1% level. This implies that increase in the household by one unit (adult)

will increase the efficiency of the farmers. This is because as more adult members are added, more quality labour is increased to carry out the farm operations timely, and hence making the production process more efficient. Several previous studies have reported household size to have positive influence on efficiency, Shehu *et al.,* (2007), Giroh *etal.,* (2008), Onoja and Achike, (2008).

Age is statistically significant at1% level. The significance indicate importance of adult as source of labour in crop production, however the positive sign means that increase in age (old age) lead to reduction in the efficiency of farmers because there is likelihood of inability to supervise farming activities and also decrease in the adoption of new innovation. According to Adebayo and Lawal (2000) the gross income of Yola metropolis farmers decrease with increase in age indicating that the older the farmers the lower their output.

The extension contact is also significant at 1% level of statistical test and had contrary sign of positive. Its significance shows the importance of the factor in crop management while the contrary sign may attribute to the poor extension services experience by farmers since the withdrawal of funding by the World Bank to the Agricultural Development Programme (ADP). This finding is in consonance with that of Omotesho *et al.*, (2008) who reported that extension contact reduces efficiency in the youth participation in agricultural programme in Ondo State. Further, the report said it was probably due to lack

of trust among participants for potency of information received from the extension agents. According to Yusuf and Adenegan (2008) since the withdrawal of the World Bank in assisting ADP in Nigeria the services of extension has not been effectively felt again. Similarly, Defhues (1999) observed that farmers in Vietnam in the District of Son La Province which cultivated new crop on the advice of the extension services recorded failure; the question was that do the farmers trust the extension agents again? Further, Edet and Nsikak (2006) had similar findings.

The coefficient of education is not significant and decreases the technical efficiency of the sugarcane farmers. This may attribute to the impression most young able people, the more they become educated the lesser they pay attention to agricultural activities in search for jobs which they think pays better. This finding is in corroboration with the works of Omotesho *et al.,* (2008) in Ondo State, who found out that increased level of education decreases technical efficiency among youths in agricultural programme.

The coefficient of the membership of association has also contrary apriori (positive) sign but statistically significant at 10% level. This also implied that the more the farmers are involved in association's activities the lesser their technical efficiency. This result may attribute to poor organisation of the cooperative associations due to potency of information received from within the participants which might have emanated from lack of trust, while its significance shows that the variable may still be essential to the respondents

when properly organised. A similar report was given by Pur, *et al.,* (2006) from studies carried out on constraints to effective performance of cooperatives in rural economic activities in Yobe State. They found out that they were more problems recorded than success in the operations of the cooperatives. Among problems identified were poor leadership, lack of commitment of members, inadequate government support and so on.

4.3.3Technical Efficiency Estimates of Sugarcane Farmers in Mubi Region

The technical efficiency indices in table 4.16 were derived from the MLE results of the stochastic production function. The results showed that the TE of the sample farmers is less than one (100%) hence variation in TE exists among them. It means that all the farmers in the study area are producing below maximum efficiency. The minimum and maximum efficiencies of the farmers are 12.60% and 97% respectively, while the mean efficiency index is 87%.

The distribution of the farm efficiency indices shows that 93.74% operate above 70% of their maximum efficiency. Some 6.26% operated between 12.60 – 70% (Table 4.16). The result suggests that an average of approximately 13% of sugarcane yield is lost because of inefficiency. Therefore opportunity exist for the farmers to increase their output by 13% to reach frontier level, this can be achieved through improved resources allocation with no additional cost. Figure 4.1 also is a bar chart that describes the efficiency distribution of the sugarcane farmers. About 53% of them had the tallest bar while the lowest were about 2% as can be seen from the chart.

Table 4.15: Maximum likelihood estimates of parameters of the Cobb-Douglas Stochastic frontier production function for sugarcane farmers.

Variables	Parameter	Coefficient	T-value
Stochastic Frontier			
Constant	β_0	4.306***	44.264
Farm size (X_1)	β_1	0.902***	19.864
Seed cane (X_2)	β_2	0.036**	2.147
Hired labour (X_3)	β_3	- 0.011	-1.152
Family labour (X_4)	β_4	- 0.005	-0.774
Pesticides (X_5)	β_5	- 0.008	-0.836
Fertiliser (X_6)	β_6	0.019***	31.870
Fuelling (X_7)	β_7	0.049***	2.832
Inefficiency Model			
Constant	∂_0	- 16.48***	-3.360
Age	∂_1	8.977***	3.713
Household size	∂_2	- 5.503***	-2.858
Experience	∂_3	0.179	0.905
Years of education	∂_4	0.0389	0.856
Extension contact	∂_5	0.272***	3.735
Membership of Association	∂_7	0.109*	1.591
Variance Parameters			
Sigma squared	σ^2	0.538***	3.895
Gamma	γ	0.984***	214.731

Source: Computer Printout of Frontier

*** Significant at 1% * *Significant at 5%

* Significant at 10%

Table 4.16: Frequency Distribution of Technical Efficiency Indices among Sugarcane Farmers in Northeast of Adamawa State for 2008/2009 Cropping Season.

Efficiency Class Index	Frequency	Percentage
0.11 – 0.20	1	0.63
0.21 – 0.30	0	0.00
0.31 – 0.40	1	0.63
0.41 – 0.50	1	0.63
0.51 – 0.60	1	0.63
0.61 – 0.70	6	3.74
0.71 – 0.80	11	6.87
0.81 – 0.90	55	34.37
0.91 – 1.00	84	52.50
Total	160	100.00
Minimum Value	0.12	
Maximum Value	0.97	
Mean Value	0.87	

Source: Computed from MLE Results

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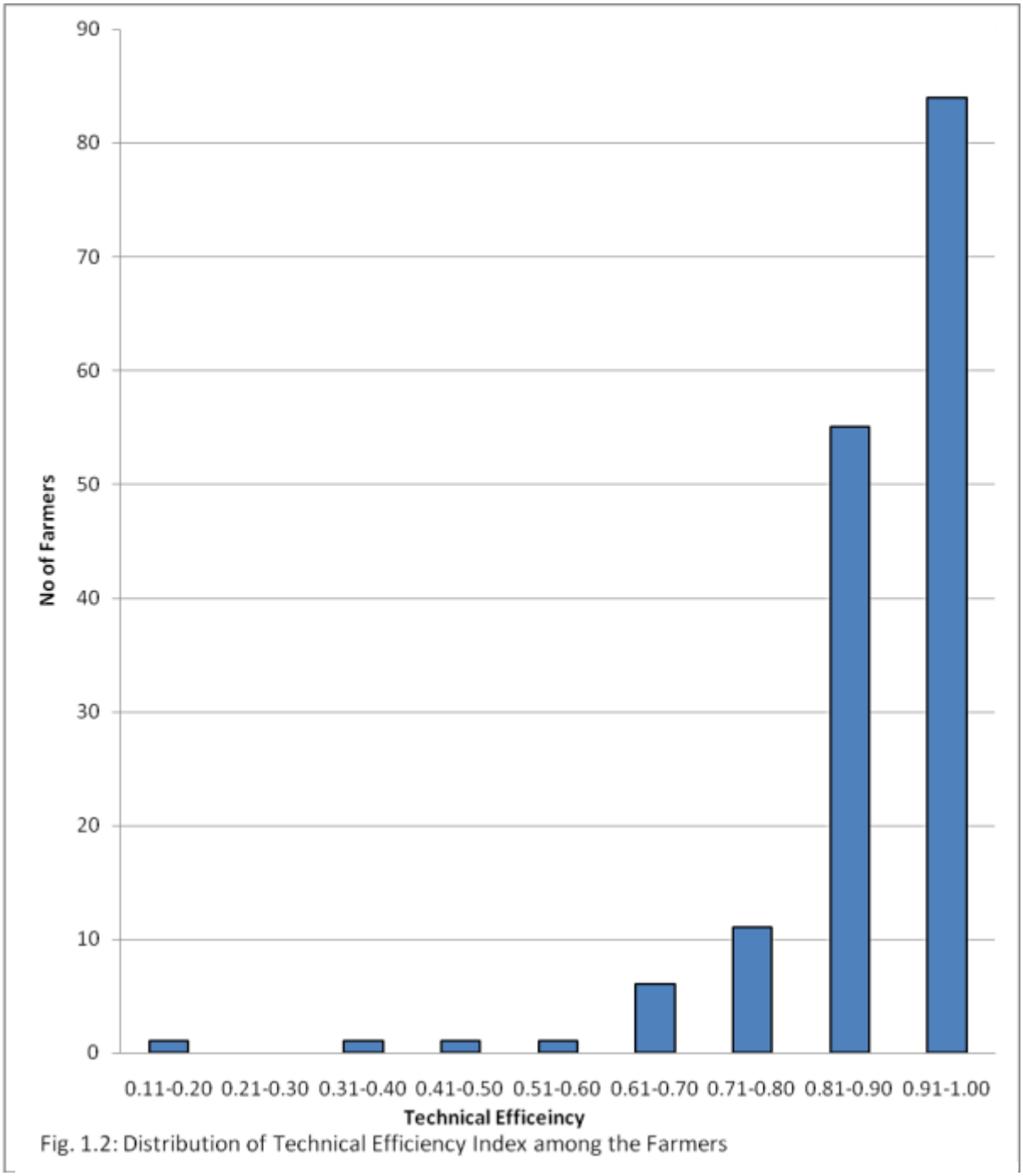

Fig.4.1: **Distribution of Technical Efficiency Index among the Farmers**

4.4 Constraints Militating Against Sugarcane Production in the Study Area

From Table 4.17, the major production constraints confronting the farmers have been analysed. Majority of the farmers (11.09%) asserted that the pest and diseases attack on their cane fields have been a threat; particularly attack of stem borer, white grub and termites which are often difficult to control. Another major factor reported was high cost of labour as reported by 10.19%, analysis of the total variable cost (TVC) in Table 4.6 shows that more than 30% accounted for the cost of labour alone this could attribute to high demand for manual labour for the crop production in the area. The escalating price of water pump was also reported by 10.13% of the respondents, this is not unconnected with the time of propagation of the crop which normally begins after the rainy season where irrigation of the fields becomes inevitable for about 4 – 6 months annually. More than 9.24% of the farmers also reiterated that inadequate credit facilities to finance the capital intensive crop has made about 85.0% of them to operate on smaller farm sizes which range from <1.0 – 2ha.

Similarly, other problems mentioned among the farmers were poor pricing for the commodity (9.17%) coupled with the high cost of transportation (9.02%) due to its bulkiness and at the same time lack of local processing plants that could buy the commodity locally. Some more pressing problems elaborated were high cost of farm inputs (8.72%), poor states of rural feeder roads (8.72%), Nefarious conduct of middlemen (8.65%) as well as the poor marketing arrangement for the commodity (8.35%) were among teething issues

confronting the sugarcane farmers. However, some problems such as high cost of seed cane and inadequate sources of irrigation water were faced by smaller proportion of the respondents as shown in the table above.

Based on these findings therefore, it can be concluded that majority of the farmers in the study area are being confronted with so many problems which militate against their increased sugarcane output. These findings are similar to Abubakar (2002) and Hessian *et al.,* (2006) who carried out similar studies at Savannah Sugar Company Numan, Adamawa State and in Pakistan respectively.

Table 4.17 Distribution of Respondents Based on Constraints Associated with Sugarcane production.

Nature of constraints	Frequency	Percentage
Pest and diseases	150	11.09
High cost of labour	138	10.19
High cost of water pump	137	10.13
Inadequate credit facilities	125	9.24
Poor pricing	124	9.17
High cost of transport	122	9.02
High cost of inputs	118	8.72
Poor state of feeder roads	118	8.72
Activities of middlemen	117	8.65
Poor marketing arrangement	113	8.35
High cost of seed cane	49	3.62
Inadequate irrigation water	42	3.10
Total	1353	100

Source: Field survey, 2010

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

In this chapter, discussion of the findings, summary of the study, conclusion and recommendations are presented.

5.1 Summary of Major Findings

The study analysed the economics of sugarcane production in the Northeast of Adamawa State. Data used for the analysis were collected from 160 sugar cane farmers using multi-stage, purposive and simple random sampling techniques. The results revealed that over 72% of the farmers were in their youthful age and most of them (93.75%) were married. Majority were males (98.12%), more so, 51.25% have at least 11 members and above in their household. Some 61.25% attended various forms of formal education and were mainly small scale with an average farm size of 1.2ha, while majority (85.01%) had <1.0 – 2.0ha. However, while, 82.5% had six years and above as farming experience in sugarcane, 85% inherited their farm lands from relations and 66.25% employed hired labour for their farm operations. Furthermore, 47.5% of the farmers had no contact with extension agents and 95.62% depended on their personal savings as capital base for production. Further, 77.5% belong to various associations and more than half (58.75%) patronise urban market in order to dispose their farm produce.

The computed gross margin and net farm income were found to be ₦111, 762.46 and ₦101,736.27 per hectare respectively which showed that production

of the crop is profitable. The benefit cost ratio on each Naira invested was 0.37, while the gross farm ratio was also found to be 0.73 and farm operation ratio of 0.70.

The results of the stochastic frontier production analysis showed the coefficients of land, fertiliser, fuelling and seed had the expected apriori sign of positive. The first three variables were statistically significant at 1% level while that of seed variable was significant at 5% level. Labour and pesticides were negative and not significant. The socio-economic variables affected the farmers' technical efficiency both in negative and positive directions. Variance parameters were both statistically significant at 1% level. The sigma squared shows good fit and correctness of distributional form assured for composite error term while Gamma (γ) shows the degree of variation in technical efficiency of the farms.

Mean TE was 0.87, while the minimum and maximum TE were 0.126 and 0.97 respectively. The farmers are operating below maximum efficiency by 13% which can be achieved through improvement on resource allocation with no cost.

Several problems were identified militating against sugarcane production in the study area. About 11.09% of the respondents reported pest and diseases as a threat to sugar cane production. High cost of labour was also reported by 10.19%; while the escalating prices of water pump were reported by 10.13% and 9.24% complained of inadequate credit facilities. Other problems identified

were poor pricing as reported by 9.17%, 8.72% stressed high cost of inputs as constraint; the poor marketing arrangement and inadequate irrigation water constitute 8.25% and 3.10% respectively.

5.2 Conclusion

The study has shown that sugarcane production in the Northeast of Adamawa State is profitable despite the problems encountered. Most of the farmers are youthful male. Profit level of sugarcane production can be increased by increasing farm size, fertiliser application, quantity of seed and suitable level of irrigation water and decreasing the use of manual labour to be substituted with farm machines and also decreased use of pesticides. About 13% of the farmers output is lost due to variation in technical inefficiency.

Recommendations

Based on the results of the findings, the following have been proffered to alleviate the problems and encourage sugarcane production in the study area.

1. The excess use of manual labour can be replaced with a labour -saving technology such as tractors and other farm machineries supplied by government at the affordable hiring prices.
2. A mini-processing plant should be sited by private companies and prospective individuals in the Northeast sugarcane producing zone like that of Sara in Jigawa State and Lau in Taraba state so that the cane produced can be processed for sugar and also for the farmers to have a guaranteed minimum price for their produce.

3. The analysis of extension service which is the source of farmers' agricultural innovations has revealed to be less effective, to save our agricultural production therefore the state in collaboration with the federal government as well as private companies should re-activate the Agricultural Development Programmes (ADP) as well as research institutions through proper funding
4. The bottlenecks involved in securing loans or credit facilities by ordinary farmers from the lending agencies should be reviewed in the farmers favour so that they can be encouraged to produce more.
5. Integrated pest and diseases control, which is a combination of good cultural practices, chemical, physical and possibly biological control with minimum disturbance to the natural environment.

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Appendix I: Questionnaire

FEDERAL UNIVERSITY OF TECHNOLOGY, P.M.B 2076,YOLA, ADAMAWA STATE, NIGERIA. DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION

RESEARCH QUESTIONNAIRE

TOPIC; ECONOMICS OF SUGARCANE PRODUCTION (RAKE) IN MUBI REGION OF THE NORTHEAST OF ADAMAWA STATE, NIGERIA

.

Dear sir/madam,

I am a Postgraduate student of the above institution conducting a research on a topic. I kindly solicit for your assistance with necessary information to the questions attached to enable me carryout the work. Information provided will be for the purpose of this research and would be treated confidentially.

Thank you.

Yours faithfully,

James Dzarma Daniel

SURVEY QUESTIONNAIRE

SECTION A

Socio-Economic Characteristics of Farmers

Kindly tick the appropriate alternatives or write correctly where it demands.

1. Name of your cell or village/town……...

2. Gender of the Respondent: (a) Male [ ]

(b) Female [ ]

3. Age of the respondent ……Years

4. (a) Main occupation…….

(b) Others: ……..

……..

……..

5. Marital status (a) Married [ ]

(b) Single [ ]

(c) Divorced [ ]

(d) Widowed [ ]

6 What is the size of your family? …….

7 Educational level of the farmer:

(a) No formal education [ ]

(b) Adult education [ ]

(c) Primary school education [ ]

(d) Secondary school education [ ]

(e) Tertiary education [ ]

(f) Others (specify) ……

SECTION B

PRODUCTION ACTIVITIES

8. How long have you been cultivating sugarcane? ……..

9. What is the size of your sugarcane farm? ……..

10. How did you acquire your farm?

(a) Renting [ ]

(b) Purchase [ ]

(c) Inheritance [ ]

(d) Others (specify)…….

11. If rented or purchased how much did you pay for one hectare? ……

……

12. Do you hire labour on your sugarcane farm?

(a) Yes [ ]

(b) No [ ]

13. If yes, please provide answer to the questions in the table below:

Table 1: Information on Hired Labour used for 2008/2009 Season.

S/N	Farm Operation	ADULT MALE				ADULT FEMALE				CHILDREN			
		No. of People Worked	No. of Days	No. of Hours	Cost (₦)	No. of People	No. of Days	No. of Hours	Cost (₦)	No. of People Engaged	No. of Days Worked	No. of Hours	Cost (₦)
i.	Land clearing												
ii.	Tilling												
iii.	Sowing												
iv.	Weeding												
v.	Fertiliser Application												
vi.	Chemical Application												
vii.	Harvesting												
viii.	Others specify												

Table 2: Family Labour used on Sugarcane Farm

S/N	Farm Operation	ADULT MALE			ADULT FEMALE			CHILDREN		
		Number engaged	No. of Days	Number of Hours	Number of People	No. of Days	No. of Hours	No. of People Engaged	No. of Days Worked	No. of Hours
i.	Land clearing									
ii.	Tilling									
iii.	Sowing									
iv.	Weeding									
v.	Fertiliser Application									
vi.	Chemical Application									
vii.	Harvesting									
viii.	Others specify									

18. Kindly fill in the necessary information for inputs utilised on sugarcane farm for2008/2009 production season.

Table 3: Information on Inputs Utilised.

S/N	Input	Source of input	Quantity Purchased	Total Cost (₦)	Transport Cost (₦)
i.	Seed Cane				
ii.	Fertiliser				
iii.	Herbicides				
iv.	Tractor Hiring				
v.	Animal Traction				
vi.	Seed dressing chemicals				

19. Table 4: Information on Fixed Capital Assets

S/N	Input	Year of Purchase	Lifespan of the Item	Source of input	Quantity Purchased	Cost of Unit of Item (₦)
i.	Hoes					
ii.	Axe					
iii.	Cutlass					
iv.	Rake					
v.	Sprayer					
vi.	Shovel					
vii.	Water Pumping Machine					
viii.	Others specify					

20. If you hire water pumping machine how much did you pay every month?

    ₦ ……..…

21. How many months do you irrigate your sugarcane farm before onset of the rains? ……

22. How many kilograms or tonnes of sugarcane were harvested from your field in 2008/2009? ……

23. How much did you sell one tonne of sugarcane in the season? ₦ ……..……

24. How much did you realise from the sale of sugarcane in 2008/2009 cropping season? ₦ ……...

25. How much did it cost you to transport your sugarcane from the farm to the various market points? ₦ ……

26. Which type of market do you sell your sugarcane?

(a) Rural Market [ ]

(b) Urban Market [ ]

(c) Both [ ]

(d) Others specify ……...……

27. What is /are the sources of your capital for sugarcane farming?

(a) Personal Saving [ ]

(b) Borrowed [ ]

(c) Others specify ……

28. If borrowed, supply the necessary information to table 5 below:

Source	Amount ₦	Interest Rate (%)
Friends / Relatives		
Commercial Banks		
Agricultural Banks		
Others		

29. How would you rate the interest charged on loan?

(a) Low [ ]

(b) Moderate [ ]

(c) High [ ]

30. Do you have access to extension services in your place?

(a) Yes [ ]

(b) No [ ]

31. If yes, how often do you have contact with the extension worker?

(a) Once a week [ ]

(b) Twice a week [ ]

(c) Forth nightly [ ]

(d) Others specify ……

32. Are you a member of any co-operative society? (a) Yes [ ] (b) no

SECTION C

PRODUCTION PROBLEMS

33. In table 6 below tick the appropriate option as referred to the problem:

S/N	Problems of Production	Very Severe	Severe	Mild
i.	Pest and diseases attack			
ii.	Inadequate irrigation water			
iii.	High costs of inputs			
iv.	High cost of labour			
v.	High cost of water pumping machine			
Vi.	Inadequate good seed cane varieties			
vii.	Inadequate credit facilities			
	Marketing Problems			
i.	Poor marketing arrangement			
ii.	High cost of transport			
iii.	Nefarious activities of middlemen			
iv.	Lack of accessible roads			
V. vi	Poor price of sugarcane Others specify; (a) …….. (b) ……..			

34. Suggest on ways you think these problems can be alleviated……..

……

……

……

……

Appendix II: Results of the Stochastic Frontier Production Function

```
instruction file = terminal
data file =        james.dat


Tech. Eff. Effects Frontier (see B&C 1993)
The model is a production function
The dependent variable is logged


the ols estimates are :

                    coefficient     standard-error    t-ratio

 beta 0          0.43149942E+01  0.23020978E+00  0.18743748E+02
 beta 1          0.79425805E+00  0.75910014E-01  0.10463152E+02
 beta 2          0.11539423E-01  0.58556932E-01  0.19706331E+00
 beta 3          0.86104341E-02  0.13925545E-01  0.61831936E+00
 beta 4         -0.34953467E-02  0.10097787E-01 -0.34614976E+00
 beta 5          0.22757171E-01  0.13973941E-01  0.16285436E+01
 beta 6          0.25388463E-02  0.99419143E-02  0.25536795E+00
 beta 7          0.16198166E-01  0.33566603E-01  0.4[illegible]+00
 sigma-squared  0.52429053E-01

log likelihood function =   0.12936854E+02

the estimates after the grid search were :

 beta 0          0.45573487E+01
 beta 1          0.79425805E+00
 beta 2          0.11539423E-01
 beta 3          0.86104341E-02
 beta 4         -0.34953467E-02
 beta 5          0.22757171E-01
 beta 6          0.25388463E-02
 beta 7          0.16198166E-01
 sigma-squared   0.10854328E+00
 gamma           0.85000000E+00
 delta 0         0.00000000E+00
 delta 1         0.00000000E+00
 delta 2         0.00000000E+00
 delta 3         0.00000000E+00
 delta 4         0.00000000E+00
 delta 5         0.00000000E+00
 delta 6         0.00000000E+00
 delta 7         0.00000000E+00


iteration =     0  func evals =     15  llf =  0.31[illegible]+02
    0.45573487E+01 0.79425805E+00 0.11539423E-01 0.86104341E-02-0.34953467E-02
    0.22757171E-01 0.25388463E-02 0.16198166E-01 0.00000000E+00 0.00000000E+00
    0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
    0.00000000E+00 0.10854328E+00 0.85000000E+00
gradient step
```

```
iteration =     5  func evals =     39  llf = 0.42140065E+02
   0.45319622E+01 0.84609624E+00-0.17529562E-01-0.10878032E-02-0.13681583E-02
  -0.44781985E-02 0.17047178E-01 0.36146947E-01-0.25977862E-01-0.38407792E-01
  -0.24169607E-01-0.25537144E-01 0.92837460E-02 0.71180575E-01 0.84586996E-02
   0.20452288E-01 0.11929563E+00 0.89032126E+00
iteration =    10  func evals =     59  llf = 0.44242855E+02
   0.44575897E+01 0.88046706E+00-0.11535134E-02-0.90244492E-02-0.30016664E-02
  -0.56849773E-02 0.17780863E-01 0.46414334E-01-0.51888662E-01-0.49445393E-01
  -0.37115987E-01-0.12995301E-01 0.34192451E-03 0.31764796E-01 0.38131810E-01
  -0.36434392E-02 0.11847963E+00 0.92019473E+00
iteration =    15  func evals =     80  llf = 0.49622922E+02
   0.44192052E+01 0.87866273E+00 0.17048961E-01-0.99026441E-02-0.44423917E-02
  -0.25338455E-02 0.19263603E-01 0.41006718E-01-0.98925121E+00 0.50078966E+00
  -0.55058490E-01 0.50801310E-02 0.78737829E-03 0.53460197E-01 0.70383604E+00
   0.10853675E-01 0.13099741E+00 0.94199686E+00
iteration =    20  func evals =    128  llf = 0.59403554E+02
   0.43046827E+01 0.88741429E+00 0.36555109E-01-0.97902046E-02-0.37959642E-02
  -0.83006416E-02 0.23656240E-01 0.51440988E-01-0.47737133E+01 0.26308351E+01
  -0.39349272E+00 0.61077126E-01 0.10392795E-01 0.10243782E+00 0.77394048E+00
   0.25093959E-01 0.21186640E+00 0.95751390E+00
iteration =    25  func evals =    186  llf = 0.63245043E+02
   0.42576168E+01 0.89076122E+00 0.50129307E-01-0.11465501E-01-0.58460943E-02
  -0.59970538E-02 0.17130253E-01 0.50659049E-01-0.10048691E+02 0.58733546E+01
  -0.14731650E+01 0.80124965E-01 0.11348382E-01 0.19450577E+00 0.48811366E+00
   0.68369363E-01 0.35814567E+00 0.97267706E+00
iteration =    30  func evals =    264  llf = 0.65055399E+02
   0.43063493E+01 0.90208670E+00 0.36467493E-01-0.11383254E-01-0.53281287E-02
  -0.81332009E-02 0.19308487E-01 0.49881202E-01-0.16354476E+02 0.89523095E+01
  -0.15044183E+01 0.17886019E+00 0.31854061E-01 0.27234716E+00 0.39046110E+00
   0.10877298E+00 0.53734070E+00 0.98426232E+00
iteration =    35  func evals =    289  llf = 0.65064872E+02
   0.43060708E+01 0.90207113E+00 0.36548571E-01-0.11386864E-01-0.53327464E-02
  -0.81110812E-02 0.19290112E-01 0.49880451E-01-0.16408523E+02 0.89778118E+01
  -0.15033623E+01 0.17959251E+00 0.32016781E-01 0.27291534E+00 0.38910439E+00
   0.10910369E+00 0.53886211E+00 0.98428320E+00
iteration =    36  func evals =    294  llf = 0.65064879E+02
   0.43060705E+01 0.90207112E+00 0.36548645E-01-0.11386866E-01-0.53327489E-02
  -0.81110706E-02 0.19290105E-01 0.49880464E-01-0.16408558E+02 0.89778281E+01
  -0.15033617E+01 0.17959305E+00 0.32016878E-01 0.27291570E+00 0.38910347E+00
   0.10910390E+00 0.53886314E+00 0.98428322E+00


the final mle estimates are :

                coefficient      standard-error     t-ratio

  beta 0        0.43060705E+01   0.97281545E-01   0.44264002E+02
  beta 1        0.90207112E+00   0.45410941E-01   0.19864620E+02
  beta 2        0.36548645E-01   0.17020744E-01   0.21473002E+01
  beta 3       -0.11386866E-01   0.98800220E-02  -0.11525141E+01
  beta 4       -0.53327489E-02   0.68854836E-02  -0.77449156E+00
  beta 5       -0.81110706E-02   0.96975383E-02  -0.83640511E+00
  beta 6        0.19290105E-01   0.60515402E-02   0.31876355E+01
  beta 7        0.49880464E-01   0.17608789E-01   0.2832/027E+01
  sigma-squared 0.53886314E+00-  0.13834208E+00   0.38951499E+01
  gamma         0.90428322E+00   0.45837958E-02   0.21473104E+03
  delta 0      -0.16408558E+02   0.48828741E+01  -0.33604304E+01
```

delta 1	0.89778281E+01	0.24173565E+01	0.37139033E+01
delta 2	-0.15032617E+01	0.52584883E+00	-0.28589236E+01
delta 3	0.17959305E+00	0.19631818E+00	0.90558036E+00
delta 4	0.32016878E-01	0.37364456E-01	0.85688063E+00
delta 5	0.27291570E+00	0.73060097E-01	0.37354960E+01
delta 6	0.38910347E+00	0.17857919E+00	0.21788847E+01
delta 7	0.10910390E+00	0.644945538-01	0.16916762E+01

log likelihood function = 0.65064872E+02

LR test of the one-sided error = 0.10425604E+03
with number of restrictions = 9
[note that this statistic has a mixed chi-square distribution]

number of iterations = 36

(maximum number of iterations set at : 100)

number of cross-sections = 160

number of time periods = 1

total number of observations = 160

thus there are: 0 obsns not in the panel

covariance matrix :

0.94636990E-02	0.26756648E-02	-0.24353224E-02	0.63607339E-04	0.52787818E-04
0.36378156E-04	-0.77888861E-04	-0.63374632E-05	0.90621911E-01	-0.46374720E-01
0.31894548E-02	-0.67710205E-03	0.41499849E-04	-0.92669817E-03	0.26437133E-02
-0.54765201E-03	-0.24332239E-02	-0.77018549E-04		
0.26756648E-02	0.20621536E-02	-0.59066858E-03	-0.14223600E-03	0.30744827E-04
-0.72686420E-04	-0.34485443E-04	-0.65914077E-04	-0.14492793E-01	0.77015612E-02
-0.41674370E-03	0.17675592E-03	0.69405020E-04	0.94340409E-04	-0.50457320E-03
0.67920816E-04	0.24128188E-03	-0.56022118E-05		
-0.24353224E-02	-0.59066858E-03	0.73012061E-03	-0.47214046E-04	-0.13761174E-04
0.72839834E-05	0.17768615E-04	-0.14828155E-03	-0.19550547E-01	0.99671012E-02
-0.75381019E-03	0.12218037E-03	-0.18492552E-04	0.16032623E-03	-0.65869152E-03
0.11325320E-03	0.55614289E-03	0.23147742E-04		
0.63607339E-04	-0.14223600E-03	-0.47214046E-04	0.97614851E-04	0.24061995E-04
-0.47403205E-05	-0.92720289E-05	-0.38031736E-05	0.97508117E-03	-0.47477964E-03
-0.14477513E-04	0.38009851E-04	0.17769107E-04	-0.44828136E-04	0.62812756E-04
-0.91618213E-05	-0.36487156E-04	-0.32202946E-05		
0.52787818E-04	0.30744827E-04	-0.13761174E-04	0.24061995E-04	0.47409885E-04
0.24264293E-05	-0.72242242E-05	0.67402916E-05	0.18528738E-02	-0.90685559E-03
-0.72206676E-04	0.42058134E-04	0.44916961E-05	-0.26313241E-04	0.47049226E-04
-0.15078184E-04	-0.53033117E-04	0.15597727E-05		
0.36378156E-04	-0.72686420E-04	0.72839834E-05	-0.47403205E-05	0.24264293E-05
0.94042249E-04	-0.26813665E-04	-0.12721021E-04	-0.76990432E-03	0.12227214E-03
0.98210323E-04	-0.94501378E-04	0.11133954E-04	0.35627150E-04	-0.10528957E-03
0.84815413E-05	0.74015149E-04	0.11982129E-05		
-0.77888861E-04	-0.34485443E-04	0.17768615E-04	-0.92720289E-05	-0.72242242E-05
-0.26813665E-04	0.36621134E-04	-0.97178929E-05	0.29464672E-02	-0.14479390E-02
-0.51251223E-04	0.21736655E-03	-0.13011410E-04	-0.32282102E-04	0.13115451E-03
-0.25322586E-04	-0.10362707E-03	-0.20026422E-05		

```
-0.63374632E-05 -0.65914077E-04 -0.14828155E-03 -0.38031736E-05  0.67402916E-05
-0.12721021E-04 -0.97178929E-05  0.31006946E-03 -0.59847531E-02  0.31634788E-02
 0.36280985E-06 -0.26955918E-04 -0.81035720E-05  0.97327212E-04 -0.10834700E-03
 0.36121369E-04  0.13105504E-03  0.60598006E-05
 0.90621911E-01 -0.14492793E-01 -0.19550547E-01  0.97508117E-03  0.18528738E-02
-0.76990432E-03  0.29464672E-02 -0.59847531E-02  0.23842460E+02 -0.11675189E+02
 0.20710712E+00 -0.35169488E+00 -0.66652137E-01 -0.26042235E+00  0.70033377E+00
-0.14832630E+00 -0.65963806E+00 -0.16320379E-01
-0.46374720E-01  0.77015612E-02  0.99671012E-02 -0.47477964E-03 -0.90685559E-03
 0.12227214E-03 -0.14479390E-02  0.31654788E-02 -0.11675189E+02  0.58436123E+01
-0.26565949E+00  0.16034461E+00  0.30593543E-01  0.13124578E+00 -0.36950694E+00
 0.74525007E-01  0.31775578E+00  0.80244500E-02
 0.31894548E-02 -0.41674370E-03 -0.75381019E-03 -0.14477513E-04 -0.72206876E-04
 0.96210323E-04 -0.51251223E-04  0.36280985E-06  0.20710712E+00 -0.26565949E+00
 0.27651700E+00 -0.19567859E-01  0.32139975E-02 -0.10180809E-01  0.53458221E-01
-0.42424586E-02 -0.26020919E-02 -0.27287550E-03
-0.67710205E-03  0.17675592E-03  0.12218037E-03  0.38009851E-04  0.43058134E-04
-0.94501378E-04  0.21736655E-03 -0.26955918E-04 -0.35169488E+00  0.16034461E+00
-0.19567859E-01  0.38330102E-01  0.15371332E-02  0.51802110E-02 -0.12353817E-01
 0.28538293E-02  0.10155420E-01  0.24146108E-03
 0.41499849E-04  0.69405020E-04 -0.18492552E-04  0.17769107E-04  0.44916961E-05
 0.11133954E-04 -0.13011410E-04 -0.81035720E-05 -0.66652137E-01  0.30593543E-01
 0.32139975E-02  0.15371332E-02  0.13961025E-02  0.68784777E-03 -0.83537759E-03
 0.37268067E-03  0.18061421E-02  0.40033338E-04
-0.92669817E-03  0.94340409E-04  0.16032623E-03 -0.44828136E-04 -0.26313241E-04
 0.35627190E-04 -0.32282102E-04  0.97327212E-04 -0.26042235E+00  0.13124578E+00
-0.10180809E-01  0.51802110E-02  0.68784777E-03  0.53377778E-02 -0.10624060E-01
 0.13565190E-02  0.75699810E-02  0.18586083E-03
 0.26437133E-02 -0.50457320E-03 -0.55859152E-03  0.62812756E-04  0.47049226E-04
-0.10520957E-03  0.13115451E-03 -0.10834700E-03  0.70033377E+00 -0.36950694E+00
 0.53458221E-01 -0.12353817E-01 -0.83537759E-03 -0.10624060E-01  0.31890526E-01
-0.40932342E-02 -0.19211175E-01 -0.44553564E-03
-0.54765201E-03  0.67920816E-04  0.11325320E-03 -0.91618213E-05 -0.15078184E-04
 0.84815413E-05 -0.25322586E-04  0.36121369E-04 -0.14832630E+00  0.74525007E-01
-0.42424586E-02  0.26538293E-02  0.37268067E-03  0.13565190E-02 -0.40932342E-02
 0.41595474E-02  0.41764754E-02  0.10188112E-03
-0.24332239E-02  0.24128188E-03  0.55614289E-03 -0.36687158E-04 -0.53033117E-04
 0.74013149E-04 -0.10302707E-03  0.13105504E-03 -0.65963806E+00  0.31775578E+00
-0.26020919E-02  0.10155420E-01  0.18061421E-02  0.75699810E-02 -0.19211175E-01
 0.41764754E-02  0.19138531E-01  0.47636819E-03
-0.77018549E-04 -0.56022118E-05  0.23147742E-04 -0.32202946E-05  0.15597727E-05
 0.11982129E-05 -0.20026422E-05  0.60598006E-05 -0.16320379E-01  0.80244500E-02
-0.27287550E-03  0.24146108E-03  0.40033338E-04  0.18586083E-03 -0.44553564E-03
 0.10188112E-03  0.47636819E-03  0.21011184E-04
```

technical efficiency estimates :

firm	year	eff.-est.
1	1	0.90935740E+00
2	1	0.93873633E+00
3	1	0.89994691E+00
4	1	0.83435376E+00
5	1	0.94092557E+00

6	1	0.91880082E+00
7	1	0.79890935E+00
8	1	0.92473972E+00
9	1	0.80030845E+00
10	1	0.94575385E+00
11	1	0.94359012E+00
12	1	0.88491610E+00
13	1	0.73074560E+00
14	1	0.83834998E+00
15	1	0.87112440E+00
16	1	0.91443497E+00
17	1	0.93111941E+00
18	1	0.91458111E+00
19	1	0.94243650E+00
20	1	0.90724614E+00
21	1	0.94652961E+00
22	1	0.88164063E+00
23	1	0.75313982E+00
24	1	0.89202129E+00
25	1	0.34762225E+00
26	1	0.62728205E+00
27	1	0.85005563E+00
28	1	0.93455782E+00
29	1	0.92579177E+00
30	1	0.84037867E+00
31	1	0.96144289E+00
32	1	0.89187613E+00
33	1	0.91673392E+00
34	1	0.91056073E+00
35	1	0.88241968E+00
36	1	0.90932983E+00
37	1	0.93668759E+00
38	1	0.89848009E+00
39	1	0.89204028E+00
40	1	0.94997139E+00
41	1	0.97744013E+00
42	1	0.92780688E+00
43	1	0.89670822E+00
44	1	0.87099706E+00
45	1	0.92341422E+00
46	1	0.91746528E+00
47	1	0.83343079E+00
48	1	0.93123251E+00
49	1	0.92865356E+00
50	1	0.92070645E+00
51	1	0.91726108E+00
52	1	0.88526015E+00
53	1	0.91214812E+00
54	1	0.97639168E+00
55	1	0.95649453E+00
56	1	0.81834366E+00
57	1	0.96337772E+00
58	1	0.92884426E+00
59	1	0.92807828E+00
60	1	0.90777359E+00
61	1	0.73580672E+00
62	1	0.91824842E+00

63	1	0.92952712E+00
64	1	0.81042401E+00
65	1	0.69530565E+00
66	1	0.93297416E+00
67	1	0.86095564E+00
68	1	0.91749069E+00
69	1	0.75298721E+00
70	1	0.89025644E+00
71	1	0.87416200E+00
72	1	0.64110616E+00
73	1	0.92507336E+00
74	1	0.94526362E+00
75	1	0.95688995E+00
76	1	0.93733522E+00
77	1	0.12686389E+00
78	1	0.92040964E+00
79	1	0.76713929E+00
80	1	0.95349463E+00
81	1	0.92473843E+00
82	1	0.93978456E+00
83	1	0.92545109E+00
84	1	0.92975970E+00
85	1	0.91554634E+00
86	1	0.94908043E+00
87	1	0.94134496E+00
88	1	0.92655791E+00
89	1	0.86534550E+00
90	1	0.84704398E+00
91	1	0.92233640E+00
92	1	0.82804454E+00
93	1	0.89524979E+00
94	1	0.91771491E+00
95	1	0.72120300E+00
96	1	0.88286008E+00
97	1	0.91774452E+00
98	1	0.94188974E+00
99	1	0.89507833E+00
100	1	0.87143098E+00
101	1	0.84212506E+00
102	1	0.94502819E+00
103	1	0.85115648E+00
104	1	0.94992514E+00
105	1	0.87986052E+00
106	1	0.89518196E+00
107	1	0.91498675E+00
108	1	0.87628118E+00
109	1	0.94841499E+00
110	1	0.88461478E+00
111	1	0.90889846E+00
112	1	0.87340875E+00
113	1	0.88448360E+00
114	1	0.92867865E+00
115	1	0.94134486E+00
116	1	0.63658379E+00
117	1	0.96643771E+00
118	1	0.74489537E+00
119	1	0.91139777E+00

120	1	0.94650119E+00
121	1	0.90799587E+00
122	1	0.93682317E+00
123	1	0.82591307E+00
124	1	0.50444085E+00
125	1	0.97589617E+00
126	1	0.55809793E+00
127	1	0.86964618E+00
128	1	0.73648806E+00
129	1	0.97103266E+00
130	1	0.94756880E+00
131	1	0.82445333E+00
132	1	0.83885264E+00
133	1	0.90829991E+00
134	1	0.8961517[illegible]E+00
135	1	0.9298998[illegible]E+00
136	1	0.94022666[illegible]+00
137	1	0.66805978E+00
138	1	0.89829449E+00
139	1	0.92548439E+00
140	1	0.91272812E+00
141	1	0.92801663E+00
142	1	0.95206925E+00
143	1	0.94742177E+00
144	1	0.96784749E+00
145	1	0.90209348E+00
146	1	0.93151539E+00
147	1	0.78195673E+00
148	1	0.87925594E+00
149	1	0.95087193E+00
150	1	0.91899662E+00
151	1	0.89858070E+00
152	1	0.94989324E+00
153	1	0.91632908E+00
154	1	0.93943968E+00
155	1	0.81681739E+00
156	2	0.94300966E+00
157	1	0.90078099E+00
158	1	0.67331204E+00
159	1	0.95973280E+00
160	1	0.94117077E+00

mean efficiency = 0.87035235E+00