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acta SATECH 3(1): 59 - 69 (2009)

Technical Efficiency Differential In Industrial Sugarcane Production:The Case Of Jigawa State, Nigeria.

D. A. Babalola[1]; O. I. Y. Ajani[2]; B. T. Omonona[2]; O. A. Oni[2] & Y. A. Awoyinka[2].

[1]*Department of Agriculture and Industrial Technology, Babcock University, Ilishan Remo, Ogun state.*
[2]*Department of Agricultural Economics, University of Ibadan, Ibadan, Oyo state*

*Corresponding author <delealways@yahoo.com>

ABSTRACT

This study assessed the efficiency differential in industrial sugarcane production in Jigawa state, among farming households benefitting from government intervention through the Millennium Village Commission Programme (MVCP) and those who are not. Two-stage stratified random sampling procedure was used to collect primary data from the households. Descriptive statistics were used to analyze household-level data. Stochastic frontier production function model (SFPFM) was used to determine and compare the technical efficiency in sugarcane production among the MVCP farmers and non MVCP farmers. The result of the analyis showed that the coefficients for farm-size, hired labour, quantity of sugarcane stem-cuttings planted, quantity of fertilizer, volume of pesticide and irrigation water used for sugarcane production were all significant factors for sugarcane production by the MVCP farmers while for non MVCP farmers, the coefficients for farm-size, hired labour, quantity of sugarcane stem-cuttings planted and quantity of fertilizer used were the significant factors for the sugarcane production. The result further indicated that non MVCP farmers were more technically efficient than MVCP farmers (mean technical efficiency of 0.70 and 0.60 respectively). Sources of inefficiecy were traced to membership of association, ecological zones and varietal differences (for the MVCP farmers) and farming experience, contact with the extension service, levels of education, access to credit, membership of organisation, participation in programme and cropping density (for the non MVCP farmers). Cost and benefit anlysis showed that more benefits accrued to the farmers supported by the MVCP. The study recommends increase in extension education in the study area. Furthermore, government should impose strict adherence to set out objectives as regards programme intervention to enhance participation and increase production efficiency.

Key words*: Government intervention; Sugarcane; Technical efficiency; Cost- benefit anlysis.*

INTRODUCTION

Sugarcane (<u>Saccharum</u> <u>sp</u>) is believed to have originated from New Guinea (Purseglove, 1976). In Nigeria, sugarcane is one of the industrial crops that, before 1982, contributed to elevating the nation's GDP in the agricultural sector. However, little attention was paid to its production after 1982 and this accounted for the collapse of some sugar factories and the consequent increase in unemployment in the country (CBN, 1999). Nigeria has vast human and natural resources, in terms of land and water, to produce enough sugar cane, not only to satisfy the country's requirement for sugar and bio-fuel, but also for export (NSDC, 2003).

Nigeria still imports about 95% of its sugar requirement and this tells on the balance of payment position of the country. In 1995, domestic sugarcane production was less than 5% of consumption in Nigeria (JARDA, 1997; Awoyinka and Ikpi, 2005). Nigeria's overall sugar consumption in 2008/09 is expected to rise to 1.3 million tons, from 1.2 million tons in 2007/08. This projection is based on population growth, as well as increasing industrial demand (GAIN, 2008). The demand- supply gap is expected to be met by importation (Wada et al, 2006; GAIN, 2008). Based on the consumption patterns and projections, Nigeria may need to spend more than ₦12 billion each year on sugar importation if local production of sugar is not encouraged and improved (NSDC, 2003). Considering the shortfall in sugarcane production in Nigeria, the government has set up research institutes and agencies to facilitate increase in sugarcane production and utilization. One of such is the Millennium Village Commission (MVC) in Jigawa state (JARDA, 2001; Awoyinka and Ikpi, 2005). However, most of the established institutes have not met the set out objectives (Olofintoye, 2002). For instance, Records have shown that farmer's access to production inputs under the MVC is a function of membership of the ruling party (JARDA, 2001; Awoyinka and Ikpi, 2005), such that industrial sugarcane is produced by farmers under the MVC and farmers outside the MVC. This situation has contributed to poor service delivery to sugarcane farmers in the state.

Although studies have been conducted on sugarcane production in Nigeria (Awoyinka and Ikpi, 2005, Wada et al, 2006), the role of the various government initiatives, specifically the Millennium Village Commission Programme (MVCP) in Jigawa state, were not well detailed in these studies.

The limited capacity of the Nigerian sugarcane sector to meet the domestic demand has raised a number of questions both in policy circle and among researchers. Central to this is the issue of efficiency of sugarcane farmers in the use of resources, ecological zone where cultivation takes place, quality of sugarcane varieties accessible to them and cropping patterns adopted. In order to accelerate sugar production and to reach the 70 percent of the country's sugar production target by 2010 as set by the National Sugar Development Council Decree of 1993, more proactive efforts at increasing sugarcane production have become imperative. Thus, the need to study the economics of sugarcane production with special reference to how combinations of various factors determine profitability and resource use efficiency among farmers.

THEORETICAL AND CONCEPTUAL FRAMEWORK

A production function is the technical relationship between inputs and outputs; that is, a function that summarizes the process of conversion of factors into a particular commodity. It shows the maximum amount of the good that can be produced using alternative combinations of the various inputs. Pioneering studies that looked at the efficiency of farms are those by Koopman (1951), Debreu (1951), Farrell (1957) and Coelli (1995). The role of efficiency in increasing agricultural production has been widely recognized and variously investigated by researchers such as Dawson, (1980); Bravo-Ureta, (1994); Ashok et al. (1995); Seyoum, (1998); Abay, Miran and Gunden, (2004); Chavas, Petrie and Roth, (2005), to mention a few.

The concept of efficiency can be said to deal with the relative performance of the processes used in the transformation of inputs into outputs. Economic theory's discussion of efficiency distinguishes it into two types: (i) allocative efficiency (ii) technical efficiency. Farrell (1957) one of the pioneers of efficiency studies distinguished the two types of efficiency through the use of the frontier production function (Xu and Jeffrey, 1998). Technical efficiency is defined by the duo as the ability to produce a given level of output with a minimum quantity of inputs under certain technology. A firm is said to be technically efficient if it produces as much output as possible from a given set of inputs or if it uses the lowest possible amount of inputs for given levels of output and input mix (Atkinson and Cornwell, 1994). Allocative efficiency refers to the ability of choosing optimal input levels for given factor prices. The total efficiency otherwise called economic efficiency is the product of technical and allocative efficiency. The degree to which technical and allocative efficiency are achieved is referred to as production efficiency. This study used Maximum Likelihood Estimates (MLE) to measure technical efficiency in sugarcane production among MVC and non MVC farmers in Jigawa state, Nigeria.

The determination of technical efficiency based on production frontier function uses two main approaches namely, the deterministic approach and the stochastic approach. Under the deterministic approach, all farms share the same production frontier technology. In which case, any deviation from the established production frontier may be attributed to inefficiency in input use which is called technical inefficiency. It can only be estimated if the inefficiency effects are stochastic and have a particular distribution specification (Battese and Coelli, 1995). The stochastic frontier production function takes care of productions which deviate from the production frontier, not necessarily because of inefficiency but due to factors beyond the farmers' control and measurement. The stochastic model was employed in determining the efficiency of the repondents in this study. The model is consistent with those proposed by Battase and Coelli (1995) following that developed by Aigner et al.(1977) and Jondrow et al. (1982) and adopted by Kalirajan, (1991); Seyoum et al. (1998); Awoyemi, (2000); and Kibaara, (2005).

METHODOLOGY

This study covered six of the 27 local government areas in Jigawa state. The chosen local governments are in zones with differing ecological conditions. They are so chosen because evidence of long term production of sugarcane existed in these regions. They include Birnin Kudu, Gwaram, Dutse, Kazaure, Auyo and Jahun. Most of the state falls within the Sudan and Guinea savannah ecology. Data were collected with the aid of a carefully designed and well-structured questionnaire, which generated adequate information on the study objectives. Sugarcane being a perennial crop, information collected from farmers was based on 5-years production activities with the assistance of personnel from both ADP in the official study area and researchers in the sugarcane estates. Data collected include those on socio-economic characteristics, farm size and location, variety cultivated; other input variables and output variables. A two stage stratified random sampling technique was used to choose respondents for the study. The first was stratification of the state into two ecological zones from which random selection of six local governments was made (two from Guinea and four from Sudan savannah).The two ecological zones were identified for sugarcane production by the state Agricultural Development Project (ADP). The second stage was the stratification of the selected local governments into the beneficiaries of the Millennium Village Commission Programme (MVCP) and non MVCP from which a total of 280 farmers were randomly sampled for this study (120 MVCP farmers and 160 non MVCP farmers, (see Table 1).

Table 1: Distribution of questionnaire to Respondents

Local Govt. Area	Ecological zones	MVCF		NMVCF	
		Distributed	Retrieved	Distributed	Retrieved
Dutse	Guinea	24 (120)	24	31 (300)	31
Birnin Kudu	Guinea	24 (120)	22	31 (250)	28
Gwaram	Sudan	24 (70)	17	31 (200)	22
Jahun	Sudan	24 (130)	22	31 (180)	30
Auyo	Sudan	24 (140)	21	31 (120)	27
Kazaure	Sudan	24 (80)	16	31 (110)	20
Total		144 (660)	120	186 (1,160)	160

Source: Field Survey, 2008

MVCF= Millennium Village Commission Farmers; NMCF= Non-Millennium Village Commission Farmers, Population of farmers in parenthesis derived from records with the MVC and farmers under extension agent supervision, collected from the extension arm of the ADP.

Data collected for the study were analyzed using descriptive, budgetary and stochastic frontier regression techniques. The descriptive analysis involved the use of frequency distribution and percentages. The budgetary technique used to examine the profitability of sugarcane production among farmers is as follows:

TVO – TVC = GM 1

GM– TFC = NFI....................................2

Where:

TVO = Total Value of Output per season; TVC = Total Variable Cost per season; GM = Gross Margin per season; TFC = Total Fixed Cost per season; NFI = Net Farm Income per season

Since sugarcane is a perennial crop, a compound factor is used to bring the value of past years to their present year value. The concept of compounding applies to an investment which takes place periodically (Kay, 1987; Awoyinka and Ikpi, 2005) and the value as at present is called the Future Value (FV) i.e.

$FV = P(1 + i)^n$

(for all the seasons considered)

Where FV = Future Value of either cost or revenue

P = the present sum

i = Interest rate

n = Number of seasons: $n \rightarrow (0 \leq n \leq 4)$ base year represented by zero.

Sequel to the above discussion, the following was computed:

a. Compound Gross Margin (CGM) = Gross Margin/season x Compound Factor (CF)

b. Compound Net Farm Income (CNFI) = Net Farm Income per season x compound factor.

c. Total Compounded Gross Margin (TCGM) = $\sum_{k=1}^{n} CGM$............3

d. Total Compounded Net farm income (TCNFI) =$\sum_{k=1}^{n} CNFI$........4

e. Total Compound Gross Margin per hectare (TCGM/ha)

$= \frac{TCGM}{THC}$ 5

where THC = total number of hectare cultivated by farmers

f. Total Compounded Net Farm income per hectare/ha)

$= \frac{TCNFI}{THC}$ 6

Where THC = total number of hectares cultivated

g. Average Compounded Gross Margin per hectare

$$(ACGM/ha) = \frac{TCGM/haU}{n} \quad ......7$$

where n = number of seasons.

h. Average Compounded Net farm income per hectare

$$(ACNFI/ha) = \frac{TCNFI/ha}{n} \quad ......8$$

where n = number of seasons.

The empirical model of stochastic production frontier model that was applied in the analysis of the influence of input variables on the Technical efficiency of crop production is specified as:

$$In\ Y = \beta_o + \beta_1\ In + \beta_2\ In\ X_2 + \beta_3\ In\ X_3 + \beta_4\ In\ X_4 + \beta_5\ In\ X_5 + \beta_6\ In\ X_6 + \beta_7\ In\ X_7 + (v_i - \mu_i) \quad ......8$$

Where;

Subscript i =ith farmer;

In = represents the natural logarithm (i.e. to base e);

Y = Total value of sugarcane output in kg,

X_1 = Farm Size in hectares

X_2 = Family Labour in Man-days

X_3 = Hired Labour in Man-days

X_4 = Planting Material in Kg

X_5 = Fertilizer in Kg

X_6 = Pesticides in Litres

X_7 = Irrigation in Litres

β_1- β_7 = Regression coefficients

v_i = A random error term or white noise assumed to capture events beyond the control of the farmers.

μ_i = Disturbance term or technical inefficiency effects

Non-physical variables that accounted for the average level of technical inefficiency, measured by the mode of truncated normal distribution (μ_i) are defined as follows;

$$\mu_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 + \alpha_8 Z_8 + \alpha_9 Z_9 \quad ......9$$

Where:

Z_1 = Faming experience (years)

Z_2 = Extension services (dummy; acess=1, no acess=0)

Z_3 = Years of education(years)

Z_4 = Access to credit(dummy; acess=1, no acess=0)

Z_5 = Membership of community based organization (dummy; belong=1, otherwise=0) .

Z_6 = Participation in programme (dummy; yes=1, no=0)

Z_7 = Ecological zone(dummy; sudan =1, no acess=0)

Z_8 = Cropping density(dummy; reccomended=1, otherwise=0)

Z_9 = Variety (dummy; improved=1, otherwise=0)

The variance ratio of μ and v is given as;

$\gamma = \delta^2/\delta^2 s$ (since gamma γ must take a value between o and 1 Sigma squared (δ^2) which is the summation of μ and v variation is expressed as;

$$\delta^2 s = \delta^2 v + \delta^2 \mu$$

RESULTS AND DISCUSSION

Result according to Table 2 summarizes selected characteristics of the sugarcane farmers according to farmers in the Millennium Village programme (MVCF) and farmers not under the Millennium Village programme (NMVCF).

Table 2 show that the mean age for the Millennium Village Commission (MVC) farmers, was 43 years and for the Non-Millennium Village Commission (NMVC) farmers the mean age was 58 years. This result implies that majority of the MVC farmers are younger compared to the NMVCF and are therefore, generally, still in their active working age. They can still contribute significantly to production for many more years *ceteris paribus*.

Majority of the farmers have one form of education or the other. However, 68 percent (133) of the NMVC farmers have only Qur'anic education, as such; they can only read in Arabic language and may not effectively use materials and equipment whose instructions are written in English. This will negatively affect production efficiency (Fawole and Fasina, 2005). The MVC farmers are better literate especially in English (Primary 18%, Secondary 25% and Tertiary 11%). This may be the motivation for their embracing and participation in the Millennium Village Program. The average household size among the respondents is generally on the high side i.e 10 for the MVC farmers and 16 for NMVC farmers. Although, this may imply higher availability of family labour but judging from the fact that majority of the women are not allowed to go to the field to work (Islamic injunction) and the huge economic cost of maintaining the large family, the poverty level among farmers is will be high. The MVC farmers have average of 8 years farming experience while the NMVC farmers have an average of 15 years of experience in farming. Based on this result, production potential, of the NMVC farmers are expected to be higher *ceteris paribus*. The result reveals that male-headed household's dominates farming households in the study area. The choice of other forms of occupation either as principal or complementary to farming is slightly higher among the NMVC farmers (17%) than the MVC farmers (16%). This difference must have been influenced by government intervention in support of agricultural production especially in Jigawa state. This result is consistent with the report of Musa (2008) who emphasizes Jigawa state government support of agriculture both at the local and state levels. Majority of the farmers do participate in community based farmers organization (66% for MVCF and 55% for the NMCF). The level of participation is however higher in the MVCF. The extension service coverage in the study area is relatively better than most other agrarian communities, many of the farmers have access to extension service (58% for MVCF and 57% for NMVCF). More of the NMVC farmers are found in the guinea savannah (45%) as compared to MVC farmers (30%). The ease of getting Government support for irrigation by the MVC farmers may be responsible for this.

Table 2: Socio-Economics Characteristics of Respondents by Program

Variables	MVF	NMVF
Age		
Mean Age	43	58
S.D	11.81	21.30
Total no of Farmers	120	160
Education		
Qur'anic	31(25%)	133(68%)
Primary	21(18%)	19(12%)
Secondary	57(48%)	8(5%)
Tertiary	11(9%)	0
Household Size (mean)	10	16
Farming Experience (mean) (yrs)	8	15
Marital Status		
Single	25(21%)	34(21%)
Married	95(79%)	126(79%)
Gender		
Male	120	160
Female	0	0
Farming	101(84%)	133(83%)
Artisan	5(4%)	0
Trading	7(6%)	17(11%)
Civil Service	7(6%)	10(6%)
Membership of Farming Organization		
Yes	41(34%)	72(45%)
No	79(66%)	88(55%)
Access to Extension Service		
Yes	70 (58%)	91(57%)
No	50 (42%)	69(42%)
Ecological Location		
Guinea Savannah	36(30%)	72(45%)
Sudan Savannah	84 (70%)	88(55%)

Source: Field Survey, 2008.

Varieties of Planting Materials, Level of Inputs Used and Cultural practices.

Result according to Table 3 shows that MVC farmers grow higher yielding varieties of sugarcane than the NMVC farmers and this have implication on the quality and quatity of output derived. Result of the t-test, according to Table 4, showed that there are significant differences in the mean of all the inputs used by MVCF and NMVCF, however, there is no significant difference in the level of output. Average farm size, fertilizer, irrigation water, herbicide, and pesticides used by the MVC farmers are higher than those of NMVC farmers while average Mandays of labour and quantity of stem cuttings utilized by NMV farmers are higher than those of MV farmers. Generally, farmers are encouraged to adopt established recommended cultural practices. Result according to Table 5 shows that none of these recommendation were followed by NMVC farmers. However, the MVC farmers, on the average, adopted only the recommended planting density of between 1,000 and 1,200 plants per hectare and weeding rate of between 4 and 5 times/ season. This implies that some of inputs which are meant to be dedicated to sugarcane production are been diverted to production of other crops and it also implies that close monitoring and follow ups by the MV commission agents is poor.

Table 3: Sugarcane Varieties Grown by Program

Variety	MVF	NMVF	Total
Co957 (HY)	46	11	57
Co62175 (HY)	33	28	61
Co1001 (HY)	24	10	34
Co997 (LY)	12	48	60
Sp71/6180 (LY	8	45	53
Co6415 (LY)	10	22	32

Source: Field Survey, 2008.

HY=High Yielding variety; LY= Low Yielding variety

Cost and Benefit Analysis of Sugarcane Production by Program

Table 7 presents the structure of cost and benefit to sugarcane production in the study area. The result shows that labour, planting materials, fertilizer, irrigation, land charges (opportunity cost) and asset costs accounted for 53.7%, 10%, 15%, 10%, 8.3% and 0.8% of the total cost of production respectively for MVCF and 34.6%, 37.9%, 15.2%, 6.2%, 5.6%, and 0.5% of the total cost of production respectively for NMVCF. This summary is presented in Table 6. The high labour cost for both MVCF and NMVCF is as a result of the intensity of labour required in sugarcane production especially in the first year of cultivation. The wide gap between the labour cost and other input costs for the MVCF is a reflection of the impact of the programme. Table 8 shows an average compounded gross margin per hectare of ₦150,808.50 for MVCF and ₦72,836.10 for NMVCF; an average compounded net farm income per hectare of ₦155,054.20 for MVCF and ₦82,837 for NMVCF. Clear indication from this result shows that more benefits accrued to the MVCF than the NMVCF as a result of the program impact.

Econometric Results for the Efficiency of Sugarcane Production

Table 9 shows the result of Maximum Likelihood Estimates (MLE) of the parameters of the stochastic frontier production function model for MVCF and NMVCF. For the MVC farmers, all production factors, except quantity of family labour, are statistically significant at 10% or less. The positive and significant estimated coefficient include farm size (β_1 = 0.12), hired labour ($\beta_{3=}$0.29), planting material ($\beta_{4=}$0.25; P<0.01), quantity of fertilizer ($\beta_{5=}$0.26; p<0.05) which conform to *a priori* expectation that sugarcane output is elastic to changes in these variables, thus, output is expected to increase with increase in these variables. The negative and significant estimated coefficient include Pesticides ($\beta_{6=}$-0.63)(p<0.01), irrigation ($\beta_{7=}$-0.07)(p<0.10). Sugarcane output is inelastic to changes in these variables, thus, output is expected to decrease with increase in these variables. For the NMVC farmers, the model revealed that all the production factors are statistically significant also at 10% or less except volumes of pesticides and irrigation water. The estimated coefficient of farm size (β_1 = 0.21), family labour (β_2 = 0.19), hired labour (β_3= 0.05), planting material ($\beta_{4=}$0.58) are positive (P<0.01), thus, output is expected to increase with increase in these variables which conform to *a priori* expectation

The negative and significant estimated coefficient include fertilizer ($\beta_{5=}$0.04)(p<0.05). Sugarcane output is inelastic to changes in level of fertilizer application, thus, output is expected to decrease with increase in this variables. The estimates of the parameters of inefficiency reveal that, for MVCF, the coefficient of membership of Community Based Organization (p<0.05), variety of sugarcane grown (p<0.01)(both with negative sign) and ecological zone (p<0.01)(with positive sign) are significant. This implies that variation in this factors constitute a source of ineffiency among the farmers. For the NMVCF, the estimate coefficient of farming experience (p<0.01), contact with extension agents (p<0.01), membership of community based organization (p<0.10), farmers participation in government programme (p<0.05)(with negative signs), years of education (p<0.05), cropping density (p<0.10)(with positive sign) are significant and constitute a source of ineffiency among the farmers. The diagnostic statistic shows that, for both the MVCF and NMVCF, the estimated sigma-signed (σ^2) is significantly different from zero at the 1-percent level. This indicates a good fit and the correctness of the specified distributional assumptions of the composite error term. In addition, for the MVCF, the magnitude of the variance ratio estimated is 0.98, suggesting that systematic influences that are unexplained by the stochastic frontier production function are the dominant sources of errors. This means that 98 percent of the variation in sugarcane output among the farms is due to differences in economic efficiency. For NMVCF, the magnitude of the variance ratio estimated is 0.95, suggesting that systematic influences that are unexplained by the stochastic frontier production function are the dominant sources of errors. This means that 95 percent of the variation in sugarcane output among the farms is due to differences in economic efficiency. The mean economic efficiency for the MVCF and the NMVCF are 0.6097 and 0.7032 respectively; and this implies that sugarcane farmers in Jigawa state are economically efficient at approximately 61% and 70% levels respectively.

CONCLUSION

This study aimed determining the efficiency differentials in industrial sugarcane production in Jigawa state in order to assess the impact of the MVC programme intervention. The result showed that the mean age of MVCFs was 43 years while the mean age for the NMVCFs was 58 years. Most of the farmers have only Qur'anic education especially the NMVCFs. Majority of the MVCFs have one form of education or the other. Mean household size for the MVCFs and NMVCFs was 10 and 16 respectively. Mean farming experience was 8 and 15 years for MVCFs and NMVCFs respectively. Majority of the farmers are married and virtually all the farmers all the sugarcane farmers are male. Majority of the farmers take farming as thier main occupation. Majority of the farmers belong to one type of community based organisation or the other. This they claim has assisted them with thier farming activities. Most of the farmers claimed to have contact with extension officers. There is a higher demand for improved or high yielding varieties of planting material by the MVCFs than NMVCFs. For other variable inputs such as farm size, labour, fertilizer, herbicide and pesticide. A t-test result shows that there is significant diferences in level of input used between MVCFs and NMVCFs. NMVCFs deviates more from recommended cultural practices than the MVCFs. Clear indication showed that more benefits accrued to the MVCF than the NMVCF as a result of the program impact. Analysis of the stochastic production frontier revealed that all factors, except family labour, were significant factors for sugarcane production by the MVCFs while for the NMVCFs, all other factors except pesticides and irrigation, were the significant factors for the sugarcane production. The result further indicated that NMVCFs were more technically efficient than MVCFs (mean technical efficiency of 0.60 and 0.70 for MVCF and NMVCF respectively). The regression analysis indicated that membership of association, ecological zones and varietal differences are sources of inefficiency for the MVCF and farming experience, contact with the extension service, levels of education, access to credit, membership of organisation, participation in programme and cropping density are the sources of inefficiency for the NMVCFs

Recommendations

Sequel to survey results, the following recommendations are proposed to enhance the impact of existing programme interventions and for future programme intervention in sugarcane production:

- The need to place strict adherance to set out goals and objectives of programmes is partinent. This will go a long way in facilitating achievable success of these programmes and further stimulate participation. Access to imput subsidies should be without any 'string' attached.
- The need to improve extension education and organising farmers into cooperative units cannot be over emphasized. This is particularly important in the study area because of the low literacy level among sugarcane producers and in sugarcane production because of the technicality involved in increasing productivity

Table 4: Inputs Used in Production by Program

Inputs	MVF	NMVF	t-calc	t-tab	Decision
Average Farm size (sugarcane) in ha	4	2.1	3.53***	1.64	reject Ho
Average Mandays of Labour/Annum	500	545	2.21**	1.96	reject Ho
Average Kg of Fertilizer	2393	1250	5.84***	2.58	reject Ho
Average Kg of Stem cuttings	19089	21471	5.96***	3.56	reject Ho
Average Litre of Water	1197000	897800	15.43***	6.23	reject Ho
Average Litre of Herbicides	1139.8	854.8	8.66***	4.20	reject Ho
Average Litre of Pesticides	883.7	662.8	12.08***	2.58	reject Ho
Average Output in Tons	418000	420000	1.08	1.64	accept Ho
Total number of farmers	120	160			

Source: FieldSurvey, 2008.

Table 5: Farmers cultural Practices by Program vis-à-vis Recommended

Variables	Recommended	MVF (Mean actual)	NMVF (Mean actual)	Total
Farm size (Ha)	5	4	2.1	2
Fertilizer (Kg/Ha)	2,000-2,500	1,393	1,250	1321.5
Planting Density/ha	1,000-1,200	1,102	1,532	1317
Weeding rate/season	4-5	4	3	3.5

Source: Field Survey, 2008.

Table 6: Summary of Input cost by Program

Input	MVF Input cost	NMVF Input cost	Total
Labour	5909268 (53.7%)	7461584 (34.6%)	13370852
Planting Material	1088876(9.90%)	8158973(37.9%)	9247849
Fertilizer	1658729 (15%)	3274449(15.2%)	4933178
Irrigation	1085675(9.9%)	1330110(6.2%)	2415785
Land charge	909,7808(8.3%)	1,213,039(5.6%)	2122819
Asset	82022 (0.8%)	102460(0.5%)	184482
Total	11003224	21540615	32543839

Source: Field survey

Table 7: Cost and Benefits Structure by Program per Season for Sugarcane Farmers in Jigawa, State, Nigeria.

Seasons	Programmes	Opportunity Cost of land (OPL)	Cost of Fixed Asset (CFA)	Cost of Irrigation (CI)	Cost of Planting Materials	Cost of Fertilizer (CF)	Cost of Labour (CL)	Total Variable Cost (TVC)	Total Fixed Cost (TFC)	Total Cost (TC)	Total Value of Output (TVO)	Gross Margin (GM)	Net Farm Income (NFI)	Compound	Compound Gross Margin	Compound Net Farm Income (CNFI)
		a	**b**	**c**	**d**	**e**	**f**	**g=c+d+e+f**	**h=a+b**	**i=g+h**	**j**	**k=j-g**	**l=j-i**	**m**	**n=kxm**	**o=lxm**
1st planting	MVF	153,539	13,842	157,133	183,765	356,810	1,071,170	1,768,878	167,381	1936259	31170000	29401122	29233741	2.14	62918401	62560205.74
	NMVF	204,719	17,303	224,477	2,888,178	595,000	1,338,962	5,046,617	222,022	5268639	21819000	16772383	16550361		35892900	35417772.54
1st ratoon	MVF	166,591	15,019	170,491	199,385	387,138	1,124,728	1,881,742	181,601	2063343	34755000	32873258	32691657	1.77	58185667	57864232.89
	NMVF	222,121	18,473	243,558	813,367	645,575	1,405,910	3,108,410	240594	3349004	26182800	23074390	22833796		40841670	40415818.92
2nd ratoon	MVF	180,751	16,296	179,697	216,333	420,044	1,158,470	1,974,544	197047	2171591	36703350	34728806	40415819	1.46	50704057	59007095.6232
	NMVF	241,001	19,881	264,260	882,503	677,854	1,448,087	3,272,704	260882	3533586	22731724	19459020	19198138		28419169	28029281.48
3rd ratoon	MVF	196,115	17,681	206,440	234,721	425,747	1,251,148	2,118,056	213796	2331852	38173685	36055629	35841833	1.21	43627311	43368617.93
	NMVF	261,486	22,631	286,722	441,252	678,000	1,563,935	2,969,909	284117	3254026	20885379	29369909	17631353		2933645	21333937.13
4th ratoon	MVF	212,784	19,184	223,987	254,672	425,800	1,363,752	2,268,211	231968	2500179	40191054	37922843	37690875	1.00	37922843	37690875
	NMVF	283,712	24,172	311,093	3,133,673	678,020	1,704,690	5,827,476	307884	6135360	20103085	14275609	13967725		14275609	13967725
Total	MVF	909,780	82,022	1085675	1,088,876	1,658,729	5,969,268	10,011,431	991802	11003224	180,993,089	170,981,658	175,873,925		253,358,279	260,491,027
	NMVF	1,213,039	102,460	1330110	8,158,973	3,274,449	7,461,584	20,225,116	223763	21540615	111721988	102,951,311	90,181,373		122362993	139164535

Source: Field survey, 2007/2008

Table 8: Average benefit accrued to the farmers

Program a	THC a	TCGM b	TCGM/HA c=b/a	TCNFI d	TCNFI/HA e=d/a	N f	ACGM/HA c/f	ACNFI/HA h=e/f
MVF	336	253,358,279	754042.5	260,491,027	775271		150808.5	155054.2
NMVF	336	122362993	364175.6	139,164,535	414180.2	5	72836.1	82837
Total	700	375721272	1118218.1	399655562	570936.5		223644.6	72217.20

Source: Field survey

Table 9: Maximum Likelihood Estimates of the Parameters of the Stochastic Frontier Production Function (Economic Efficiency Model) for Sugarcane Farmers in Jigawa State.

Variable	Parameter	MVF		NMVF	
		Coefficient	Standard Error	Coefficient	Standard Error
Production factor					
Constant	β_0	17.7016***	0.9108	18.0315***	0.9982
Farm Size	β_1	0.12546***	0.0408	0.2069***	0.0162
Family Labour	β_2	0.3505	0.0875	0.1854***	0.1372
Hired labour	β_3	0.2926***	0.0663	0.0489***	0.1158
Planting Material	β_4	0.2536***	0.0406	0.5834***	0.0636
Fertilizer	β_5	0.2616**	0.1148	- 0.0412**	0.1306
Pesticides	β_6	- 0.6334***	0.0757	- 0.5942	0.0949
Irrigation	β_7	- 0.0674*	0.0685	- 0.0820	0.0831
Inefficiency factors					
Constant	δ_0	14.8114**	6.9513	7.4658***	2.5196
Faming experience	δ_1	0.0808	0.0931	-0.2508***	0.0415
Extension services	δ_2	2.6562	1.3326	-1.2408***	0.9899
Years of education	δ_3	0.2449	0.1301	1.1143**	0.6011
Access to credit	δ_4	5.1732	2.4023	3.5133	1.3535
Membership of org.	δ_5	-0.4661**	0.1979	-0.1284*	0.0688
Participation in programme	δ_6	1.5179	1.0921	-0.1755**	0.9160
Ecological zone	δ_7	0.4811***	0.0799	1.4268	0.9674
Cropping density	δ_8	0.7758	0.8352	0.7164*	0.7629
Variety	δ_9	-0.1010***	0.0094	2.9016	1.0651
Diagnastic statistics					
Sigma-squared (σ^2)		6.2168***	2.3448	2.1829***	0.4656
Gramma (γ)		0.9747***	0.0105	0.9490***	0.0178
Likelihood ratio		-267.941***		99.906***	
Mean efficiency		0.6097		0.7032	
Number of observation		120		160	

Source: Summarized from computer Print out. ***Significant @ 1%; **Significant @ 5%; *Significant @ 10%

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