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Full Length Article

Productivity and Resource use Efficiency in Sugarcane (*Saccharum officinarum*) Production in Numan Local Government Area, Adamawa State, Nigeria

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Abstract

The study was conducted to analyze productivity and resource use efficiency in sugarcane production by random selection of 120 out grower farmers. Data collected were analyzed using production function analysis. Results of the analysis revealed that the coefficient of multiple determinations (R^2) was 0.797 this means that about 79.70% of variation in the dependent variable was explained by variations in the explanatory variables. Farm size and sett were statistically significant at 5 and 1% probability level. Sugarcane production was in stage one of the production frontier (irrational zone of production) as evidenced by elasticity of production (1.147) implying either under or over utilization of resources among farmers. Recommendations were also made in the study. © 2013 Friends Science Publishers

Keywords: Sugarcane; Out grower; Resource; Jaggery; Baggasse; Production function

Introduction

Sugarcane (*Saccharum sp.*) is one of the most important crops in the world because of its strategic position and immense uses in the daily life of any nation as well as for industrial uses aimed at nutritional and economic sustenance. Sugarcane contributes about 60% of the total world sugar requirement while the remaining 40% comes from sugar beet (Onwueme and Sinha, 1999). It is a tropical crop that usually takes between 8–12 months to reach maturity. Matured cane may be green, yellow, purplish or reddish considered ripe when sugar content is at its maximum (Onwueme and Sinha, 1993).

Total world area and production of sugarcane as estimated in 1989 were 16.7 million hectares and 1,007 million metric tons, respectively. Brazil, china, Cuba, Mexico, Pakistan, Thailand, USA, Colombia, Australia and Indonesia are the leading countries in sugarcane production. Brazil, India and Cuba are the leading countries in sugarcane production, producing over half of the total world sugarcane production. Africa in the same reporting period has 1.2 million hectares with 72.1 million metric tons, respectively (Onwueme, 1978). The important sugar-producing countries in the tropical Africa are Mauritius, Kenya, Sudan, Zimbabwe, Madagascar, Cote d'Ivoire, Ethiopia, Malawi, Zambia, Tanzania, Nigeria, Cameroon and Zaire. Nigeria is one of the most important producers of the crop with a land potential of over 500,000 hectares of suitable cane field capable of producing over 3.0 million metric tons of sugarcane. If processed, it will yield about 3.0 million metric tons of sugar (NSDC, 2003).

Nigeria has been abundantly blessed with human, water and environmental potentials for the production of sugarcane. Areas with high potentials for commercial sugarcane/sugar production have been identified through studies sponsored by the Federal Ministry of Industry and conducted by Dutch consultants HVA in the early eighties (80s). The National Sugar Development Council has further confirmed that over 40 locations are suitable for sugarcane cultivation in commercial quantities at least to meet the raw material requirement of the sugar industries (NSDC, 1995).

It should be pointed out that most of the areas in the Northern States where water for irrigation is available; sugarcane cultivation in large quantities is feasible. The crop can be rotated or even inter-planted with other crops where land with adequate sources of water abounds like in the various River Basin Development Authority Areas. The long hours of sun shine and its intensity in the north is one of the major determinants of the high yield potentials of sugarcane and other similar crops.

However, the conditions as they cannot be explored effectively without setting investments in the form of development of water resources with irrigation, infrastructure and the building of factories, which are beyond the capabilities of local farmers/entrepreneurs. This fact is the main reason for the country's inability to develop the sugar industry despite its potentials.

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The current estimated sugarcane production of the nation as at 2002 is put at over 1.0 metric tons. However, the production ranged from about 607,000 tons in 1970 to about 920,000 tons in 1992 and from then there was a declining trend. It is important to note here that these figures represent the combined production of both industrial and domestic consumption. Generally, sugarcane for domestic consumption is produced more than that produced for industrial use for obvious reason. Thus, chewing cane accounts for between 55–65% of the total cane production. The bulk of these is of course consumed raw for sweetness of the juice but some of it is also processed into a variety of products such as sugar, molasses, baggasse "Jaggery" (Mazarkwaila), sweets (Alewa) and left – over leaves/stalks (Misari, 1997).

Although there is vast potential for the commercial production of sugarcane, its processing industry did not come into existence in Nigeria until the early 1960s (Abdullahi, 2000). Commercial cultivation of sugarcane did not start until 1950, while industrial production of refined sugar stated in the early 1960's with the establishment of the Nigeria Sugar Company (NISUCO) at Bacita, Kwara State in 1964. Since then another mill, the Savannah Sugar Company (SSCL) took off at Numan, Adamawa State in 1980 and smaller one in Lafiagi in 1983. Similarly, National Sugar Development Council, Abuja is installing a medium-sized 250 ton-cane-day mini sugar plant at Sunti, Niger State. The combined installed capacities of these mills are about 120,000 metric tons of processed granulated white sugar per annum. However, total domestic production has fluctuated between 16,000 and 50,000 metric tons annually, which are able to meet only about 5% of the total national demand for sugar (Misari, 1997).

The sugar industry is the major user of the sugarcane as its raw material source their requirement from local producers through the concept of out growers scheme of cane delivery. This is the major practice in Nigeria. Under this concept, sugarcane farmers are organized to grow and supply sugarcane for processing by the existing sugar plants. The purpose here is to encourage the production of sugarcane to feed sugar mills through the activities of smallholder and corporate out-growers. This approach tends to minimize the overhead cost of sugarcane processors and enable them to concentrate on processing rather than growing of sugarcane (NSDC, 1996).

In order to be able to continue production with reduction in overhead costs of any investment, many agricultural production enterprises resorted to contracting out the production of its raw materials to the farmers that lives within and around their respective companies so as to concentrate only on processing. This arrangement will ensure steady supply of raw material, employment generation and economic empowerment of the rural communities as well as reduction in rural-urban migration. In the case of the Savannah Sugar Company Limited, Numan for it to maintain the peaceful co-existence with its immediate community is providing array of social services such as health, education, electricity etc. In addition, it went further to apportion part of its estate farm and allocated to the communities so as to keep the communities employed throughout the year with generation of employment to the teeming population living around the company. This arrangement in which the company contracts out their raw material production is referred as out grower's scheme.

Savannah Sugar Company Limited, Numan (SSCL) was incorporated in 1971 and an in-depth feasibility study was carried out in 1973, which ended up with a proposal for the integrated development of irrigated sugar estate and a mill with capacity to produce 100,000 tonnes of refined sugar annually. The total project area covers approximately 27,000 hectares. At the onset of the company, it was estimated that 12,000 hectares of land would be developed by 1985 for the cultivation of irrigated sugarcane. However, production did not start until 1980/1981 and only 2,500 hectares of land was developed by 1982. The main focus of this study was to economically assess the sugarcane production amongst the out farmers of Savannah Sugar Company Limited, Numan. The objective was to examine the resource use efficiency in sugarcane production and to ascertain the major constraints impede sugarcane production in the study area.

Materials and Methods

Study Area

The study was conducted in Numan, Numan Local Government Area of Adamawa States of Nigeria. It lies between Latitudes $9^o10''$ and $9^o39''$ N of the equator and between Longitudes $10^o24''$ and $12^o55''$ E of the Greenwich Meridian. Numan covers a land area of 2,193 km^2 and shares boundary in the north with Balanga Local Government Area of Gombe State, Shelleng and Guyuk Local Government Areas of Adamawa State, while Lamurde Local Government Area of Adamawa State, Karim Lamido Local Government Area of Taraba State in south east and Demsa Local Government Area to the South. The climate of Numan is that of Guinea Savannah region ranging from 28^oC to 32^oC with a mean rainfall of 676 mm. It has a tropical climate marked by dry and rainy seasons. The rainy season starts in April and ends by October. The out grower farms of Savannah Sugar Company are located in six out grower zones each and managed by estate mangers. They include Zekun, Gyawana, Lafia, Danto and Opallo estates. Irrigation is done by the use of irrigation water from Kiri Dam, which commences two or three weeks after the rain stops. The land has good and favourable soil made up of alluvial and vertisol soils (Tukur and Adebayo, 1997).

Sources of Data and Sampling Technique

Data for this study was obtained mainly from primary source collected using structured questionnaires in a random sampling technique. Forty farmers each were selected from the six out grower zones giving total of 240 farmers out of which 120 were retrieved and used for the study.

Method of Data Analysis

The data collected were subjected to descriptive and inferential statistics. The inferential statistics included production function. The production function is specified as:

$Y = f(X_1, X_2, X_3, X_4, X_5 + \mu)$ (1).

Where: Y = Yield of sugarcane in tonnes, X_1 = land (hectares), X_2 = setts (tonnes), X_3 = Labour (man days), X_4=fertilizer (kg), X_5 = water (M^3) and μ_1 = the error term (assumed to have zero mean and constant variance). Four functional forms (Linear, Semi-log, Exponential and Cobb-Douglas) were tried using ordinary least square technique (OLS). The estimated functions were evaluated in terms of the statistical significance of R^2 as indicated by F-value, the significance of the coefficients as given by the t-values, the signs of the coefficient and the magnitude of standard errors. Based on these statistical, economic and econometric criteria, the Cobb- Douglas functional form was selected as the lead equation which is explicitly specified as follows:

$\log Y_1 = \beta_o + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + \mu$ (2).

Where: Y_1 = Yield of sugar cane (tonnes) of the ith farmer X_1 = land (hectares) X_2= setts (tonnes) X_3 = Labor (in man days) X_4 = fertilizer (kg) X_5 = water (M^3).

To examine the resources use efficiency, Cobb - Douglas production function was used in a multiple regression form so as to compute the marginal value product (MVP) of the resources such as setts, land, labour, fertilizer and irrigation water employed in the production process. Marginal value productivity (MVP) of the input used in this model were computed using the equation:

$MVPX_1 = b_1.(Y/X)(P_y)$ (3)

Where: MVPX = marginal value product of ithinput.

MVPXi=bi(Y/X).Px

Where: Y=Geometric mean of the output, X= Geometric mean of ith input Py=Unit price of the output, and bi = Regression coefficient (elasticity of production) with respect to i the input. The efficiency ratio of the inputs was then estimated by dividing the marginal value product (MVP) of each input by its corresponding marginal factor cost (MFC). Similarly, the elasticity of production (Ep) in respect of each of the input was given as a regression coefficient of the inputs. Likewise, returns to scale of the out grower farmers were determined by the addition of all the elasticities of production (Ebi).

Results and Discussion

Production Function Analysis and Resource Use Efficiency

Multiple regression analysis was used to measure the effect of the independent variables land (X_1), seed (X_2), labour (X_3), fertilizer (X_4) and irrigation water (X_5), on the total output of sugarcane (Y). The result is presented in Table 2. Accordingly, the table shows that the coefficient of multiple determinations (R^2) was 0.797, which implies that 79.7% of variation in the dependent variable (Total Value Product) was explained by variations in the explanatory variables namely; land, Seeds, labour, fertilizer and irrigation water included in the model. The remaining 20.3% was attributed to the random error term (μ). The F - ratio of 57.38 was significant ($P<0.01$). The estimated regression equation is presented as:

$Y = 1.42 + 0.553X_1 + 0.586X_2 - 0.075X_3 + 0.083X_4 + 0001X_5 + \mu$ (1).

The coefficient with respect to a particular variable shows the extent to which variation in that variable explains variation in the dependent variable. In Cobb-Douglas production function model, the regression coefficient, therefore, represents the elasticities of production with respect to each of the corresponding explanatory variables: land, seeds, labor, fertilizer and irrigation water. Thus, for land as an input, the elasticity of production was found to be 0.553 implying that an increase in the size of land (farm size) by 1.0%, while holding all other factors of production constant, will increase the yield of sugarcane by 0.553%. The t ratio value of 2.45 for land was also found to be significant ($P<0.05$). Thus, farmland is a very important factor that determines the total output of sugarcane produced by the farmers in the study area. This is similar to the findings of Umar and Haruna (2005) that farm size was an important determinant of farm output among farmers in Nigeria.

The sugarcane sett has an elasticity of production of 0.586. This means that an increase in the sugarcane sett by 1.0%, while holding all other inputs constant will increase the output of sugarcane by 0.586%. Sett was found to be an important input determining the output of sugarcane and was found to be significant ($P<0.01$). Haruna and Kushwaha (1999) also observed that influence of was significant in sorghum yield in Bauchi State. Similarly, the elasticity of production for fertilizer and irrigation water were found to be 0.083 and 0.001, respectively. This implies that any increase in fertilizer and irrigation water inputs by 1.0%, while holding other inputs constant, will lead to an increase in the total output of sugarcane by 0.083% and 0.001, respectively though they were not found to be significant. However, the negative elasticity value of -0.076 was found for labour input. This implies that 1% increase of this input will not lead to an increment in the total output of sugarcane rather will decrease the output by 0.075% and the labour input was found not to be significant.

Table 1: Regression Coefficient and t-values from the Cobb-Douglas Production Function

Variable	Coefficient	t. ratio
Constant	1.4169	4.42***
Land(X_1)	0.5527	2.45**
Seed(X_2)	0.5858	5.07***
Labour(X_3)	-0.0755	-0.61
Land(X_4)	0.08295	0.89
Water(X_5)	0.00109	0.02
F ratio	57.38***	
R^2 adjusted	0.797	
RTS	1.147	

Source: Data analysis 2002. **, ***Significant at 5 and 1% probability levels

Table 2: The Marginal Values Productivities and Acquisition costs of inputs

Input	Acquisition cost	Marginal value product (MVP)	Efficiency ratio MVP/MFC
Land	1000	1633.39	1.633
Sett	1500	1752.65	1.168
Labor	11750	226.57	0.019
Fertilizer	2665	114.52	0.043
Water	2000	3.27	0.002

The Cobb-Douglas production function was selected because it gives the best fit of the recession equation with F-ratio and some of variables significant. Also the regression coefficients give the direct values of elasticity of the variables used in the model. R2 was also found to be high i.e., 79.7%. Return to scale is defined as the sum of the elasticities of production (Ep) with respect to all the variable inputs used in a production process. This measures the proportionate change in output, if all the inputs utilized changed simultaneously by 1%. In this study, the sum of elasticities of production with respect to all inputs was 1.1471, which implied that if all the explanatory variables (lands, seed, labor, fertilizer and water) are simultaneously increased by 1%, the total value of product will increase by 1.14%. This result indicates that increasing returns to scale prevails among the small-scale sugarcane producers in the study area.

Marginal Value Productivities (MVPs) and Resource Use Efficiencies

Marginal Value Product (MVP) of land (N1633.39) was higher than its marginal factor cost (MFC) of NI000 fha (Table 2). Also the efficiency ratio for land was computed to be 1.633. As a general rule, a ratio greater than 1 indicates under-utilization of a resource, while less than 1 shows an over-utilization of the resource. Since a ratio of 1.633 was obtained it means that land was under-utilized below economic optimum levels and profit could be increased, an increased in the level of land utilization for sugarcane production. Also sugarcane setts have the MVP of N1752.65, MFC of N1, 500 and efficiency ratio of 1.168. This also indicates its utilization below the economic optimum level as confirmed by the findings of Abdu et al (2004) who found that land was used below economic optimum level amongst the traditional potato producers in Plateau State Nigeria. Hence, could be improved if the farmer in the study area could plant more setts of improved varieties. Labor input has an MVP of N226.57, MFC of 11750 and efficiency ratio of 0.019. This shows its usage above the economic optimum level for sugarcane production. Profits could be realized by reducing the labour employment in this enterprise. Similarly, the fertilizer input and water had the efficiency ratios of 0.043 and 0.002, respectively. This means that these two inputs were over-utilized in sugarcane production in the study area. More profit could be realized by the sugarcane farmers in the study area if they could reduce both the levels of fertilizer and water inputs in sugarcane production.

Conclusion

The study has shown that resources are insufficiently utilized in the production process of sugarcane by contact out growers and therefore if his system is to be improved, re-allocation of resources for better use is encouraged. The out grower scheme will continue to be sustained if they provide employment to the communities living within and around the company and there by strengthening the social and economic well-being of the farming communities and increasing the net returns of the company in the long run. It is recommended that there should be timely provision of agro-inputs/mechanical services to the farmers as well as sufficient Irrigation water for enhancing farmers' operation, which could lead to higher yield. An effective system should be put in place where farmers should be linked with service providers and community money lenders. To meet the demand of the company in terms of high quality cane supply and to generate sufficient funds for the out grower farmers, the issue of low cane yield should be addressed through provision of high yielding, disease resistant, productive and pest/disease free farms through expansion of the estate farms.

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