Economic Analysis of Sugarcane Crop Production in *Elguneid* Scheme, Sudan (2017-1997)

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Abstract

The main objective of this paper was to estimate Cobb-Douglas production function and supply response function of sugarcane for Elguneid Scheme during the period 2017-1997The paper utilized time-series data obtained from the scheme's statistics reports and publications and depended on quantitative analysis. Results revealed that irrigation, labour, fertilizer, pesticides and cultivated areas affected sugarcane production. The coefficient of determination R^2 was 0.99% implies that there is highly positive relationship between production andthe above variables. The supply response in the long run is inelastic. The paper recommends vertical and horizontal expansion of sugarcane production, introduction of smart technologies and adoption of good quality sugarcane varieties policies for sugarcane production .and productivity

Keywords: Cobb-Douglas production functionsupply response function time series data, vertical and horizontal expansion, smart .technologies

Introduction:

The past few decades have seen wild fluctuations in sugarcane production. Sugar, being a basic component of the food basket of all strata of the society, such fluctuations have attracted attention of academicians to design policy measures to manage these fluctuations. The supply of sugar depends to a great extent on the production of sugarcane. Therefore, reducing fluctuations in sugarcane production would be one way to stabilize sugar prices. It is in this context that a thorough analysis of the factors responsible for the variations in the sugarcane output is needed.

Sudan is the top largest producer of sugar in Africa, after South Africa and Egypt (Belgees and Fager, 2005). Sugar industry in the Sudan started with the establishment of Elguneid Sugar Scheme by the German company groups (Siement, Buckan and BMA) in the Gezira province in 1962. There are five sugar factories in the Sudan, four of these factories are state-owned, namely: Elgunied, New Halfa, Sinnar and Assalaya, the fifth is the Kenana Sugar Company which incorporated in 1975 as a joint venture between Sudan, Arab countries and others (Abd Elmonim, 2009). Sugar is considered as one of the major strategic commodities in the Sudan, employs over 15,000 people, drawn from all regions of Sudan, with a further 4,000 seasonal

workers also employed, in addition to the other social, health and educational services offered by sugar factories to the local population in that regions as well as electricity, roads and telecommunication services (Abdel Elmoniem, 2009). Furthermore, with increasing exports from sugar it could have hard currency and then refresh national economy.

Elguneid sugar factory is the oldest sugar factory in Sudan, which was established to meet the local Sugar demand and reduce imports of White Sugar. Also aimed to bring development in to the area. Production relationship in Elgunied Sugar Scheme differs slightly from these adopted in Gezira Scheme. The tenancy arrangement is that the state owns the land; on the other hand, the production relation for the three factories New Halfa, Sinnar, and Assalaya are based on direct labour which the factory own the land and crop. (Elawad, 1983).

Elguneid sugar scheme (GSS) was confined to the specialization of sugar production, with the same tenancy relationship of Gezira scheme model. The scheme is located at the eastern bank of the Blue Nile at Gezira state, South of Khartoum, Butana province north of Ruffa town. The scheme lies between latitude 140-150- north and longitude 330 -380-east and occupies an area of 40, 170 faddens out of which 2700 feddanes are under sugarcane produces 950 tons of sugar .

Climate is cool in November to march, hot and dry April-October. Soil of Elguneid area is similar to these of Gezira on the western side of the Blue Nile. Elguneid commercial sugar production started in 1962/1963 with 13260 tons of sugar and 18 tons cane/fadden which represents less than half the potential for the first five years so the scheme runs at economic losses.

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Production and productivity of sugarcane in Elguneid scheme were fluctuated from year to another, so there is need to determine factors that affecting sugar production and how these factors affecting sugar productivity. This paper attempts to estimate Cobb-Douglas production function and supply response function of sugarcane for Elgunied Sugar scheme during the period 1997 to 201.7

Research methodology:

The study utilized time series data collected from the annual publications by the scheme statistics reports and the Ministry of Agriculture's publications. The collected data were analyzedand using multiple regression by SPSS program, multiple regression were used to examine the factors that believed to affect sugarcane yield, The data were collected from statistical office and Elguneid Sugar factory during seasons (1997–2017), The study adopted quantitative analysis using multiple- regression to estimate Cobb-Douglas production function and supply response function of Sugarcane for Elgunied Sugar scheme during the period 1997 to 2017,

The theoretical framework of the model

Production function is a technical relationship between a set of inputs or resources and a set output or goods, or it is technical relationship between inputs and given level of output (Rubin Feld and Mehto, 2012).The real value function of several variable arises in economics, is the

production function from the theory of a firm, assume that (($x1$, … . . , n) is the bundle of goods used to produce a single product.

Let

q the quantity of the output produce,

f the function,

$x1$, xM, quantity of inputs.

q = ($x1$,….., x m) …….. (1)

The function that gives the amount produced in terms of the amount of the input goods, this function is called the production function.

There are various forms of the production function that have been used.

Linear: q =a1x1+a2x2

Input = output

q= quantity of sugarcane produced- X1, X2 =quantities of inputs - c = cost

$x_{1\geq c}1q$ for each x to produce q quantity of the output,

Cobb-Douglas production function

q $= f(x_1, x_2) + x^a$

inputs variables are labour and capital ، L designed for labour and K for capital. In this case, the production function is

$q = f(L, K) = L^a K^b$…….. (2)

Where

A is a constant, if both labour and capital are scaled by factor s, then

$$f(sL, sK)(sL)^a(sK)^b = S^{a+b}AL^aK^b = S^{a+b}f(L, K)$$

And the economy increase by a factor of S^{a+b}

Case 1:

a +b = 1

often 0< a< 1 and 0 <b = 1-a < 1

In this case, the function is said to have constant Return to scale.

Case 2:

a+b> 1. In this case, when s>1, f(sL, sK)=

$S^{a+b}(L, K) > sf(L, K)$

the function is said to have an increase returns to scale.

Case 3:

a+b<1

in this case, when s >1, f (sL, sK) = S^{a+b} $(L, K) < sf(L, K)$ the function is said to have a decrease returns to scale, (CMA, B.V and Prabhakar)

Specification of the production function variables

A production function can be expressed in afunctional form as

Q= f (x1, x2, x3 ,….xn)

Where:

Q = quantity of output.

X1,x2,x3 ….xn = quantities of factor inputs (such as capital, labour land or raw materials).

If G is not a matrix, then this form do not encompass joint produce, which is production process has multiple produces one formulation, unlikely to be relevant in practice, is a linear function

G = a +bx1 + cx2 +dx3+.....

Where:

a,b,c and d are parameters that are determined empirically. Another is as a Cobb – Douglas production function

G = ax1 b X2,G = min (ax1 , bx2 , …)

Other forms include the constant elasticity of substitution production function (CES), which is a generalized from of the Cobb Douglas function, and the quadratic production function. The best form of the equation use and the values of the parameters (a,b,c…) varies from company to company and industry to industry. In short run production function at least one of the x is (inputs) is fixed. In the long run all factor inputs are variable at the discretion of management (Chiange, 1984).

The short run analysis of production function is done with one input variable labour (L) and the other input constant capital (K). The variation in the output resulting from different number's of labour applied to a fixed quantity of capital is explained with the help of law of diminishing returns or law of variable proportions. The long run analysis of production function is done with both the input (L,K) variables. The variation in the output resulting from different amounts of labour and capital employed is explained with the help of law of returns to scale (Sahima, 2009). The first steps of production function analysis is to determine whether the analysis focuses on short term or long term operations. This defines the scope of analysis. Then the next step is to evaluate supply and demand. The ultimate goal of production function analysis is to identify the level of diminishing marginal returns by determining the point at which supply outruns demand businesses knows how much produce to product to maximize profits (Sahima, 1995). The elasticity of area was negative and insignificant. The inverse relationship might be attributed to intense use of labour, thus confirming the result of Thopas (1999).The functional relationship between sugarcane yield and six independent variables, such as area under cultivation, numbers of labour, irrigation, fertilizer urea and super phosphate,herbicides and pesticide were estimated by fitted multiple types of regression equations separately, of sugarcane planting. The estimates of the functional analysis were worked by using equation given below.

$$Y=B0 + B1X1 + B2X2 + B3X3 \ldots\ldots\ldots Bn\ Xn+Ut$$

Y : stands for sugarcane yield .

a intercept

B : stands for regression coefficient of respective resource variable

X1: stands for labour.

X2 : stands **for**irrigation,

X3 : stands for **.fertilizer urea**

Yx4 : stands for **.Pesticides**

x5 : stands for mechanical Labour,

Ut : stands for error term

Agricultural supply response is a term used to describe the degree to which production changes due to changes in some important variables, such output price, scale of production and prices of substitutes. The concept attempts to explain behavioral response of producers to changes in economic incentives (Nkang *et al.*, 2007). Reliable estimates of supply are important for predicting farmer responsiveness to input, output prices and thereby for formulating successful agricultural incentive programmes consistent with national goals (Ullah *et al.*, 2012). :Purpose of supply response analysis is to examine how output responds to changes in factors that influence supply and are amenable to manipulation through policy (Mose, 2007). The adaptive expectations and partial adjustment models are the two variants of the Nerlove supply model (Mose, 2007), which is a widely used dynamic approach for supply response (Ozk *et al.*, 2011). Both the adaptive expectations and partial adjustment models employ the OLS technique to estimate a dynamic specification of supplyresponse (Mose, 2007). Ties that the estimates are based on the underlying assumption that the data processes are stationary because the data are regressed in their level form (Mose, 2007).

Results and Discussion:

The estimation results are given in tables 1 to 4. All the models were tested for residual autocorrelation using the LM test and also for normality of residuals. The multiple linear regression equation has been used for studying the relationship between sugarcane yield and input variables. The form of function used for estimating the numerical values of parameters of various independent variables affecting sugarcane yield. The result or output from the regression gives a measure of how strong the relationship between multiple variables being used in the model.

Table 1. Model summary

R-Squre	**0.991**	**Mean square**	**274.472**
Adj- Rsquare	0.982	Std. Error of the Estimate	1.32246
Sum of squares	1372.359	Durbin watson	2.803
Sum squared residual	24.485	Sig	.000

Source:.Authors calculation (2017)

As figures in Table 1 show, the coefficient of multiple determinations R2 was very high 0.99، indicated that the equation explains 99 per cent of total variation in sugarcane yield is due to variations in the independent variables, it has very strong explanatory power, adjusted R2 is .97% and Durbin Watson statistic was 2.803. F-value was 0.000 and statistically significant at 5% level of significance, indicating that the regression model of production function fitted very well and can test for the three types of returns to scale based production function with F test and T test. It was found that P-value of 0.00 which is less than the chosen significance level, showing a significantly statistical positive relationship between the model variables.

Table 2. Parameter estimates of value of coefficient

Variables	Parameter estimates	Stander Error	T Value	Sig
Constant	-62.236	22.109	-2.815	0.014
Labour day season/ fadden	0.908	0.316	0.266	0.012
Irrigation m^3/fadden	1.186	0.336	3.533	0.003

Fertilizer Urea kg/fadden	0.001	0.22	0.069	0.946
Pesticides liter/fadden	5.358	2.091	2.562	0.023
Mechanical labour hour	1.072	0.571	1.877	0.82

Source. Authors calculation(2017).

As given in table 2, all parameters estimates are positive(calculated from empirical data and error (e2) is multiplicative explanation error).This type of production function is particularly useful since it is liner in logarithms and can be used to determine whether the inputs exhibit an increasing, decreasing or constant returns to scale. As yield or sugarcane increased by amount greater than one ∝ +B >1, in this case the estimates production function described an increasing returns to scale. The results suggested that coefficients of three inputs,namely,Labour,Irrigation,and Pesticides weresignificant, these coefficients are positively related with dependent variable. Production function results revealed that the elasticity of labour 0.90 , elasticity of irrigation 1.186, elasticity of fertilizer urea 0.001, elasticity of pesticides 5.358 and elasticity of mechanical labour 1.07 with positive signs, it concluded that any increase in inputs would increase sugarcane yield and production, this results revealed that a hundred percent increase in labour, irrigation, fertilizer urea, pesticides and mechanical labour could increase yield by 90% , 1.19% , 0.001% , 5.358,and 1.07 respectively.

Let y denote output or yield in physical homogeneous units and L (labour), I (irrigation), Fu (fertilizer urea), P (pesticides) and M mechanical , then the production function is y – f (A, L, I, Fu, Fs, P ,m) the numbers of these factors can take on positive value for given technology، the function is normally specified as unvalued. The homogeneous function of degree ∝ +B if ∝ +B=1 then increasing area, labour and other inputs by the same proportion, will increased output by that proportion constant reruns to scale prevails. Decreasing and increasing returns to scale correspond to the case ∝ +B <1 and ∝ +*B*>1 tended to cover the case of many inputs and many outputs.

Supply response function of sugarcane

This study estimates supply response function of sugarcane during the study period using adaptive expectation model. Estimation is based on dynamic panel data approach with pooled across section – time series data for Elgunied Sugar scheme. The standard procedure is to use area as an indicator of supply due to the season that area design is totally under the control of farmers more ever using supply conceals some variation in area and yield, price, and net return of Sugarcane they more in the opposite directions. Supply response based on the dual relationship between area and supply function. Using coefficients estimated from the Cobb-Douglas production function. The function is estimated using ordinary least square (OLS)

Table 3. Model summary

Model summary						
Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Change Statistics	
					R Square Change	F Change

1	.292[a]	.85	.87	.05504	.85	.495

Model summary

Model	Change statistics			Durbin-Watson
	df1	df2	Sig. F Change	
1	3[a]	16	.691	1.376

a. Predictors: (Constant), log yield, log net, log real

The data was fed to equation, which is supply area response function the value of multiple correlation coefficient R^2 was .085 which indicated that 85% variation in the yield was explained by the explanatory variables , and adjusted R^2 is .87 . F test statistically significant only .495 of variation in crop area was recouped by the two independent variables which are significant

Table 4. Analysis of variance

Model		Sum of squares	Df	Mean square	F	Sig.
	Regression	0.05	3	0.02	0.495	.691[b]
1	**Residual**	0.48	16	.003		
	Total	0.53	19			

Source: Author calculations(2017) .

As shown in Table 4 sum of squares of regression was 0.05 and it mean square was 0.02 and the sum of squares of residual was 048 and between squares was 0.003. The F-value was 0.495 was highly significant at 5% level of significant indicating that the regression model of supply response function fitted very well.

$\text{Log } A = 9.66 + 0.671 X_1 + 0.007X_2 - 0.009 X_3 + 0.13X_4$

The value of coefficient of constant term was ,9.66 the area under cultivated in current year (At) and area (A_{t-1}), real farm price P_t -1 , net return sugarcane and yield of sugarcane in (y_t–1).

The coefficient of area was 9.671 show that the current year cropping area of Sugarcane is affecting positively by independent variable. it means an increase in the area raises the current year cropping area of .Sugarcane The sugarcane yield was found to bepositively affect sugarcane supply in the long-run with an elasticity of (yt-1) was 0.13 it shows that the current year cropping of yield of Sugarcane, is affecting positively by yield in the pervious year .This implies that, in the long-run, a one percent increase in the yield of sugarcane would lead to a 0.13 percent increase in the yield in the following season .a hundred percent increase in area will increase the yield yt-1 by 13%. The current year area under sugarcane crop may be based significant by farmers in the scheme .The coefficient of net return of Sugarcane was positive 0.007. It shows that the current year crop area of sugarcane is affecting positively by the net return. It mean that increase the area under cultivated will increase the area under sugarcane crop and Sugarcane yield which leads to increase net return of Sugarcane. The coefficient of price or real farms price was negative and inelastic implies that an increase in the price would

lead to a decline in the land allocated to sugarcane in the long run and in significant current years this variation Sugar area is a significant. The increase in border price of sugarcane must be beneficial to small farmer if opportunity cost of land (before Sugar planting) is low or farm prices reflect the actual demand in the market.

Conclusion and Recommendations

Present research was under taken to identify the factors affecting sugar cane yield and production in Elguneid Sugar Factory. The study reveal that the inputs or factors of sugar cane were the important factors, which influence the return of sugar production. technical efficiency was examined by using the cobb-Douglas production function the results from the model strangely suggest that the measures like composite reliability and goodness - of fit represent their respective latent constructs well. in other worlds, the findings of the model correspond to very good result and provide important new insights. This supports the point that it solves problems, not only in a agriculture sector but may be in the industrial sector.

The paper recommends vertical and horizontal expansion of sugarcane production, introduction of smart technologies and adoption of good quality varieties of sugarcane.

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تحليل اقتصادي لإنتاج محصول قصب السكر في مشروع الجنيد السودان 2017-1997

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الملخص:

نفذ البحث في مشروع الجنيد في السودان خلال الفترة من1997الي2017 .اعتمدت الورقة على البيانات الأولية وبيانات السلسلة الزمنية المتوفرة في تقارير ومطبوعات المشروع . تم استخدام دالة استجابة العرض لتحقيق هدف الدراسة. أظهرت نتائج الدراسة أن متغيرات الري والعمالة والتسميد ومبيدات الحشرات والمساحات المزروعة في الموسم السابق كانت أهم العوامل المؤثرة على دالة استجابة العرض. توصي الورقة بضرورة تطبيق التكنولوجيا الذكية والتوسع الأفقي والراسي لإنتاج قصب السكر في مشروع الجنيد إضافة إلى تبني الحكومة لحزمة من السياسات الاقتصادية التي تحفز الإنتاج والإنتاجية.

الكلمات المفتاحية: دالة إنتاج كوب دولاس دالة استجابة العرض، بيانات السلسلة الزمنية، التوسع الأفقي والراسي، التكن التكنولوجيا الذكيةَ.