Determinants of Total Factor Productivity (TFP) among Sugarcane Farmers in Kwara State of Nigeria

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ABSTRACT

The present research empirically determined the factors influencing total factor productivity (TFP) of sugarcane producers in the Kwara State of Nigeria. Data were obtained from using the 2017-2018 sugarcane cropping season field survey through the administration of a structured questionnaire complemented with an interview schedule on 105 sugarcane farmers selected via multi-stage sampling technique. The collected data were analyzed using the conventional TFP index and censored regression model. From the empirical findings, it was observed that inefficiency in the allocation of working capitals, capital consumption, and health-related challenges decreased the TFP of sugarcane farmers in the studied area. However, the study advised the extension agents to educate farmers to be rational in resource allocation in order to optimize their productivity in sugarcane production. In addition, the study advised farmers to adopt health precautious measures in order not to predispose their family members to tropical diseases and should imbibe savings and investment cultures.

Keywords: TFP, Sugarcane, Farmers, Kwara State, Nigeria.

INTRODUCTION

The empirical literature has widely recognized the importance of productivity, and its importance will further increase due to the limited possibility in further expansion of the cultivated area, pressure on limited land resources for agricultural activities as evidenced by farmers/herders clashes, population explosion, urbanization growth and expected increase in income. Therefore, to evaluate the sources of growth and to recognize the impact of changing government policies, productivity analysis is very essential.

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Productivity can be measured by partial and total factor productivity (TFP). Partial measures of productivity can be misleading, as there is no clear indicator of why they change (Block, 1994). For example, land and labor productivity may rise due to the increased use of agrochemical or output mix. To account for at least some of these problems a total measure of productivity, the total factor productivity (TFP), was devised (Nadeem et al., 2010).

In the study area, the land resource for agriculture is shrinking owing to competing demand for its use which is visible by the escalating rift between farmers and herders on a continuous basis, thus leading to unnecessary loss of lives and properties. Therefore, a further increase in agricultural production has to be achieved by enhancing the productivity of the land.

According to Samarpitha et al. (2016) and Goyal et al. (2006), productivity can be increased via one or a combination of its determinants-the technology, the quantities and types of resources used, and the efficiency with which the resources are used. Therefore, embarking on new technologies is meaningless unless the full potential of the existing technologies is explored.

An estimate on the extent of TFP can help to decide whether to improve productivity efficiency or to develop new technologies to raise sugarcane production in the studied area. Also, inefficiencies in the TFP of sugarcane may also arise due to socio-economic factors which have a correlation, thus the need to explore this possibility. It is in view of the foregoing that the present research was conceptualization with the aim of identifying the factors that determine the TFP of sugarcane farmers in the Kwara State of Nigeria.

RESEARCH METHODOLOGY

The Kwara State of Nigeria lies between longitudes 40 20' and 40 25' East of the Greenwich meridian and latitudes 80 30' and 80 50' North of the equator. The population of the state is approximately 2.3 million and has a landmass of approximately 36,825 square kilometers with varying physical features like hills, lowlands, rivers etc. Its vegetation is derived from savannah with two distinct wet and dry seasons, with mean annual precipitation and monthly temperature of 1000-1500mm and 250C-340C, respectively (Anonymous, 2010). The major occupation of the inhabitants is agricultural activities complemented by trade, artisanal, Ayurvedic medicine, etc. The present research used undated data elicited through a structured questionnaire complemented with interview schedules from 105 active sugarcane farmers during the 2017 production selected via multi-stage sampling design. In the first stage, one agricultural zone, namely zone B was purposively selected due to its comparative advantage in the production of sugarcane. In the second stage, two LGAs viz. Edu and Patigi which made up the selected agricultural zone were automatically selected as both have the potential for the production of sugarcane in the studied areas. Because of the limited number of villages producing sugarcane in the selected LGAs all the villages were considered. Therefore, a total of seven villages: five (5) villages from Edu LGA and two (2) from Patigi LGA were the areas of coverage. In the last stage, fifteen sugarcane farmers from each of the selected villages were randomly selected: seventy-five (75) and Thirty (30) active farmers from Edu and Patigi LGAs respectively. Thus, a total of 105 active farmers were chosen for the study.

For the reliability test of the questionnaire, the questionnaire was pre-tested in a pilot survey made up of 15 farmers from the sampling population and the estimated Cronbach Alpha value was 0.86, indicating high reliability and consistency of the questionnaire. With the aid of trained enumerators, ex-post data of the 2017 sugarcane cropping season were collected in the year 2018. The collected data were analyzed using the

conventional Total factor productivity (TFP) index and a censored regression model.

Model Specifications
Total factor productivity (TFP)

Following Key and Macbride (2003), the TFP approach adopted is presented below:

$$\text{TFP} = \frac{Y}{TVC} \quad \text{... (1)}$$

$$\text{TFP} = \frac{Y}{\sum P_i X_i} \quad \text{.. (2)}$$

Where, Y is output quantity (kg), TVC is a total variable cost, P_i is the unit price of ith variable input and X_i is the quantity of ith variable input. This methodology neglects the TFC as it does not affect both the profit maximization and the resource use efficiency conditions since the study focused on small-scale farmers. Total fixed cost is constant as it is sunk.

From cost theory:

$$\text{AVC} = \frac{TVC}{Y} \quad \text{.. (3)}$$

Where AVC is an average variable cost in Naira (N). Therefore, the transpose of AVC will be TFP:

$$\text{TFP} = \frac{Y}{TVC} = \frac{1}{AVC} \quad \text{....................................... (4)}$$

As such, TFP is the inverse of the AVC. The partial productivity estimate is the marginal product given as

$$\text{MP} = \Delta TFP / \Delta X \text{.. (5)}$$

Censored model:

Following Sadiq et al. (2018), the original Tobit model developed by James Tobin a Nobel laureate economist (Tobin, 1958) is given below:

$$Y_i^* = \alpha + X\beta + \varepsilon_i \text{.. (6)}$$

Where Yi* is a censored variable.

Now, $Y_i = 0$ if $Y_i^* \leq 0$
   $= Y_i^*$ if $Y_i^* > 0$

$$Y\_i\hat{} \ *= \alpha\_0 + \beta\_1 X\_1 + \beta\_2 X\_2 + \beta\_3 X\_3 + \beta\_4 X\_4 + \beta\_5 X\_5 + \beta\_6 X\_6 + \beta\_7 X\_7 + \cdots\ldots + \beta\_n X\_n + \varepsilon\_i \text{... (7)}$$

Where:
Y_i^* = TFP index of ith farmer
X_1 = Sucker (kg)
X_2 = NPK (kg)
X_3 = Urea (kg)
X_4 = Herbicide (litre)
X_5 = Family labour (man day)
X_6 = Hired labour (man day)
X_7 = Farm size (hectare)
X_8 = Depreciation on capital items (₦)
X_9 = Unit price of output (₦)
X_{10} = Yield (kg)
X_{11} = Age (Year)
X_{12} = Marital status (Married =1, Otherwise = 0)
X_{13} = Educational level (Formal = 1, Otherwise = 0)
X_{14} = Household size (Number)
X_{15} = Farming Experience (Year)
X_{16} = Land ownership (Yes =1, Otherwise = 0)
X_{17} = Non-farm income (Yes =1, No = 0)
X_{18} = Extension contact (Yes = 1, No = 0)
X_{19} = Co-operative membership (Yes =1, No = 0)
X_{20} = Access to credit (Yes =1, No = 0)
X_{21} = Sickness (Number)
X_{22} = Security threat (Yes = 1, Otherwise = 0)
X_{23} = Income (₦)
α = Intercept
β_{1-n} = Estimated coefficients
ε_i = Error term

RESULTS AND DISCUSSION
Measuring Total Factor Productivity (TFP) of Sugarcane Famers in the Studied Area

The results showed that almost half of the sampled farming population had their productivity to be below the optimal point i.e., less than unity which owed to inefficiencies in the rationalization of their farm resources, while 50.5% were productive in the use of their

resources as indicated by their TFP indices which were greater than unity (Table 1). However, 46.7% of the sugarcane farmers were found to be at the marginal surface of the TFP index, indicating that their output-input index ratio was almost equal. Therefore, the farmers with marginal TFP need to enhance their allocation efficiency to maximize their output in sugarcane production in the studied area.

Table 1: Distribution of Total factor productivity indices of farmers in the studied area

TFP indices	Frequency	Percentage
<1.00	52	49.5
< 2.00	49	46.7
< 3.00	4	3.8
Total	**105**	**100**
Mean	**1.0815**	
Minimum	**0.3913**	
Maximum	**2.5105**	
Standard deviation	**0.4186**	
Variance	**0.1752**	
Coefficient of variation	**0.3871**	

Source: Field survey, 2018

Determinants of TFP of Sugarcane Farmers in the Studied Area

The significance of the Chi2 at 10% degree of freedom means that the Tobit regression model is the best fit for the specified equation and the variable parameter estimates encapsulated are different from zero, thus having a significant influence on the explained variable (Table 2). In addition, the diagnostic test of the model showed the absence of a collinear relationship among the predictor variables as indicated by their respect variance inflation factors (VIF) which were less than the VIF benchmark value of 10.00. However, the stochastic term was not normally distributed as evidenced by the significance of the Chi2 test statistic which is within the radius of 10% degree of freedom. Though, the non-

normality of the disturbance term is not seen as a serious problem as data in their natural form are not normally distributed. Furthermore, the empirical evidence showed TFP of sugarcane farmers to be influenced by some working capital: sucker, NPK, human labor, and land; yield and idiosyncratic variables: education, non-farm activities, extension contact, sickness of the farm family, and income as indicated by the significance of their respective estimated coefficients which were within the radius of 10% probability level. The negative effects of both sucker and NPK coefficients (p<10%) indicate the excess utilization of the foregoing inputs due to the availability of stock and subsidy for the former and latter, thus decreasing the TFP of sugarcane farmers in the studied area. The negative significance of the labor coefficient means that both the free labor and the complemented labor (hired) were in excess, thus decreasing the TFP of sugarcane producers in the studied area. However, the reasons for excess labor used may be attributed to the availability of family labor which is at free cost, and the cheap cost of hired labor whose reward is mostly in kind. The marginal and elasticity implications of a unit increase in the sucker, NPK, family labor, and hired labor will decrease TFP of sugar cane by 3.13E-5 and 0.137%;8.28E-5 and 0.121%; 0.00049 and 0.272%; and, 0.00053 and 0.413%, respectively.

The positive significance of the land coefficient implies that large-scale farmers have high TFP due to economies of scale i.e., pecuniary advantages. In addition, the positive significance of the unit price of the output indicates the positive effect of remunerative price in increasing the TFP of sugarcane farmers in the studied area. If the price received by the farmers is remunerative or farmers' term of trade is favorable, they will be encouraged to invest appropriately in the production of sugarcane, thus an increase in the TFP of the sugarcane in the study jurisdiction. Furthermore, the positive significance of the yield shows how high productivity due

to efficient management of farm resources increased the TFP of sugarcane farmers in the studied area. Therefore, the marginal and elasticity implications of a unit increase in farm size, a unit price of output, and yield will increase TFP of sugarcane farmers by 0.025 and 0.968%; 9.93E-5 and 0.624%; and, 1.28E-5 and 0.956%, respectively.

The results showed that educated farmers had high TFP in sugarcane production due to their ability to be efficient in the management of their farm resources and their receptive attitude towards innovation and adoption. The marginal and elasticity implication of being educated will increase the TFP of sugarcane production by 0.0029 and 0.026% respectively. The positive effect of non-farm income on TFP implies that farmers with a diversified income had high TFP in sugarcane production due to the tendency of supplementing their farm capital investment from the extra income earned from non-farm activities. Thus, the marginal and elasticity implications of farmers with non-farm income will increase their sugarcane TFP by 0.0062 and 0.009%, respectively. The findings revealed that sugarcane farmers with access to extension services viz. innovation and counseling had high TFP in sugarcane production as indicated by the positive significance of extension contact estimated parameter. Therefore, the marginal and elasticity implications of TFP of sugarcane farmers with access to extension service will increase by 0.0081 and 0.016% respectively. The results showed that households with health challenges would have declined TFP as medical consumption will affect the income stream or capital base of the farm investment. Also, the labor pool of the farm family will be affected both in quality as there will be distraction and quantity that will be available for farm activities. In addition, the cost of hiring extra labor for strenuous/tedious farm operations will further deplete the capital investment of the farm, thus affecting the sugarcane farmers' TFP. In fact, the dearth consequences of ill health of farm family members are enormous, thus cannot be over-emphasized.

The marginal and elasticity of TFP of sugarcane farmers with sick family members will decrease by 0.0014 and 0.054%, respectively.

However, for those non-significant idiosyncratic variables, there is a need to draw little empirical inference with respect to their signs. The negative sign of the age coefficient showed that the decline in labor efficiency of old farmers tends to decrease the TFP of sugarcane. The negative coefficient of experience indicates conservative attitudes of experienced farmers towards innovations, thus a decline in their TFP. The negativity of farm ownership status showed how the effect of fragmentation on inherited farmland, the communal disposition to commercial production decreases TFP of sugarcane production in the studied area. The inverse coefficient of credit implies that farmers with no access to credit have declined TFP due to inadequate farm productive resources and constrain to adopt sugarcane production innovations. Also, the inverse relationship of security threat coefficient means that farmers who faced security challenges viz. communal conflict and herders attack had declined TFP in sugarcane production.

On the other hand, the effect of socio-economic power inherent in marriage exerts a positive effect on the TFP of married sugarcane farmers in the studied area. Also, farmers with large farm households composed of able-bodied people had high TFP in sugarcane production which is attributed to a decrease in the cost of labor and an increase in the farm capital investment owed to the generation of non-farm income. Farmers who belong to the social organization had high TFP in sugarcane production due to pecuniary advantages viz. bulk discount in input purchase, access to required and timely credit delivery either in cash or kind, efficient diffusion of innovation and bargaining power in the marketing of their outputs.

Table 2: Determinants of sugarcane farmers' TFP in the studied area

Variable	Coefficient	t-stat	Elasticity	VIF
Constant	−0.04955(0.01435)	3.453***	-	
Sucker	−3.133E-5(9.75E-6)	3.212***	-0.1369411	3.087
NPK	−8.284E-5(2.04E-5)	4.058***	-0.1211215	2.182
Urea	−3.276E-5(4.04E-5)	0.810^{NS}	-0.0340584	1.984
Herbicide	−1.073E-4(4.29E-4)	0.249^{NS}	-0.0046013	2.197
Family labour	−0.000497(0.00010)	4.892***	-0.2721591	4.451
Hired labour	−0.00053(5.49E-5)	9.540***	-0.4129293	2.319
Farm size	0.0246019(0.00092)	26.68***	0.9683564	4.147
Capital item Dep.	−6.826E-9(9.32E-8)	0.073^{NS}	-0.0012776	3.507
Unit price of output	9.931E-5(2.85E-5)	3.487***	0.6238543	1.273
Yield	1.275E-5(1.21E-6)	10.57***	0.9556377	1.304
Age	−0.000116(0.00013)	0.878^{NS}	-0.0672339	2.055
Marital status	0.00391(0.00444)	0.879^{NS}	0.0477135	1.445
Education	0.00289(0.00168)	1.721*	0.0260312	1.443
Household size	0.000176(0.000256)	0.685^{NS}	0.0284074	2.174
Farming Experience	−3.802E-5(0.00022)	0.171^{NS}	-0.0039653	1.998
Land ownership	−0.001799(0.00174)	1.037^{NS}	-0.0148589	1.304
Non-farm income	0.006239(0.003618)	1.724*	0.0096144	3.423
Extension contact	0.008046(0.002927)	2.749***	0.0160019	2.540
Co-operative mem.	0.000331(0.006529)	0.051^{NS}	0.0003844	8.521
Access to credit	−0.005978(0.00709)	0.842^{NS}	-0.0052458	8.025
Sickness	-0.001439(0.000813)	1.768*	0.0536665	1.440
Security threat	−0.000537(0.00265)	0.202^{NS}	-0.0004684	1.922
Income	−7.017E-10(1.91E-10)	3.683***	-0.0144162	1.236
Chi^2 (χ^2)	**2802.06***			
Normality test (χ^2)	**7.729[0.0209]**			

Source: Field survey, 2018

*, **, *** and ^{NS} means significance at 10%, 5%, 1% and non-significant respectively

Note: ( ): values in parenthesis are standard error; [ ] values in square brackets are probability levels

CONCLUSION AND RECOMMENDATIONS

Based on the findings it can infer that farmers' TFP is affected by working capital which is due to excess supply, sickness, and income in the studied area. Therefore, the study recommends that farmers should create alternative opportunities in which excess human labor could be channelled, thus enhancing its efficiency. In addition, the change agents should teach and encourage farmers to be efficient in the allocation of their productive resources in order to maximize TFP in sugarcane production. The farmers should be encouraged to be rational in their consumption needs so that the going concerns of their businesses would be efficient. Health is wealth, and for the direct correlation of health with productivity to be efficient, there is a need to strengthen the health institutions in the studied area by the government, non-governmental organizations, and the farmers, as the provision of good health is a joint responsibility. The farmers should be given proper sensitization by the health, educational and social institutions on the imperative of maintaining precautions that will guarantee good health. Furthermore, the study recommends the need to explore the neoclassical TFP index and decomposition productivity index of sugarcane farmers using time series data in order to strengthen the government policy on sugarcane productivity in the studied area. The

incorporation of these recommendations will help to reduce the importation of sugarcane, revitalization of sugarcane industrialization and revitalization the rural

economy in the studied area in particular and the country in general.

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محددات إنتاجية العامل الكلية (TFP) بين مزارعي السكر في ولاية كوارا في نيجيريا

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ملخص

حدد البحث الحالي بشكل تجريبي العوامل التي تؤثرعلى انتاجية العامل الكلية (TFP) لمنتجي قصب السكر في ولاية كوارا في نيجيريا. تم الحصول على بيانات المسح الميداني لموسم محصول قصب السكر 2017–2018 باستخدام استبيانة منظم مكمل بجدول مقابلة مع 105 مزارع لقصب السكر تم اختيارهم عن طريق تقنية أخذ العينات متعددة المراحل. تم تحليل البيانات التي تم جمعها باستخدام مؤشر TFP التقليدي ونموذج الانحدار الخاضع للرقابة. لوحظ من النتائج التجريبية أن عدم الكفاءة في تخصيص رؤوس الأموال العاملة واستهلاك رأس المال والتحديات المتعلقة بالصحة خفضت من TFP لمزارعي قصب السكر في منطقة الدراسة. ومع ذلك ، نصحت الدراسة وكلاء الإرشاد بتثقيف المزارعين ليكونوا منطقيين في تخصيص الموارد من أجل تحسين إنتاجيتهم في إنتاج قصب السكر . بالإضافة إلى ذلك ، نصحت الدراسة المزارعين بتبني تدابير صحية وقائية من أجل عدم تعريض أفراد أسرهم للأمراض المدارية ، وينبغي تشرب ثقافة الادخار والاستثمار .

الكلمات الدالة: إجمالي إنتاجية العامل الكلية , قصب السكر , مزارعون , ولاية كوارا نيجيريا.