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

Sanusi Mohammed Sadiq [1,2]*, Invinder Paul Singh [2], Muhammad Makarfi Ahmad [3] & Muhammad Lawal [4]

[1]Department of Agricultural Economics and Extension, FUD, Dutse, Nigeria.

[2]Department of Agricultural Economics, SKRAU, Bikaner, India.

[3]Department of Agricultural Economics, BUK, Kano, Nigeria.

[4]Department of Agricultural Education, Federal College of Education, Katsina, Nigeria.

***Corresponding Author Email:** sadiqsanusi30@gmail.com

Abstract

The competing demand for land for other purposes and the consequence of climate change is shrinking the available arable land, thus threatening the food security and livelihood of the farmers and the nation. Therefore, the present research empirically determined the factors influencing Total factor productivity (TFP) of sugarcane producers in Kwara State of Nigeria. The 2017/2018 sugarcane cropping season field survey data obtained through administration of structured questionnaire complemented with interview schedule on 105 sugarcane farmers selected *via* multi-stage sampling technique was used. The collected data were analyzed using 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 decrease 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.*

1 INTRODUCTION

The empirical literature has widely recognized the importance of productivity. Its importance will further increase due to the limited possibility in further expansion of

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 (Oseghale, 2018). Therefore, to evaluate the sources of growth and to recognize the impact of changing government policies, productivity analysis is very essential.

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 labour productivity may rise due to 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) as it encompasses both the partial productivity i.e. marginal effect and the elasticity.

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 combination of its determinants such as 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 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 conceptualized with the aim of identifying the factors that determine the TFP of sugarcane farmers in Kwara State of Nigeria.

2 MATERIALS AND METHODS

2.1 Description of Study Area

Kwara State of Nigeria (Figure 1) lies between longitudes 4.33 and 4.42^{o} East of the Greenwich meridian and latitudes 8.50^{o} and 8.83^{o} North of the equator. The population of the state is approximately 2.3 million and has a landmass of approximately 36,825 square kilometres with varying physical features like hills, lowland, rivers etc. Its vegetation is a derived savannah with two distinct wet and

dry seasons, with mean annual precipitation and monthly temperature of 1000-1500 mm and 25^{o}C-34^{o}C, respectively (Anonymous, 2010). The major occupation of the inhabitants is agricultural activities complemented by trade, artisanal, *Ayurvedic* medicine etc.

2.2 Data Collection

The present research used undated data elicited through structured questionnaire complemented with interview schedule from 105 active sugarcane farmers during the 2017 production selected using 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 Local Government Areas (LGAs) of Edu and Patigi, which made-up the selected agricultural zone were automatically selected as both have the potentials in 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 using simple random sampling technique: 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 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 2017 sugarcane cropping season were collected in the year 2018.

Figure 1: *Map of Kwara State, Nigeria.*

Source: ww.medium.com

2.3 Data Analysis and Modelling

The collected data were analyzed using conventional TFP index and a censored regression model following Key and Macbride (2003) as follows:

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

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

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 i^{th} variable input. This methodology neglect the total factor cost (TFC) as it does not affect both the profit maximization and the resource use efficiency conditions since the study focus on small-scale farmers. TFC is constant as it is sunk. From cost theory:

$$AVC = {}^{TVC}/_{Y} \quad \text{..... (3)}$$

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

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

As such, TFP is the inverse of the AVC. The partial productivity estimate is the marginal product given as MP = $\Delta TFP/\Delta X$ ……..…….... (5)

Following Sadiq et al. (2018), Y can be modelled using the original Tobit model by Tobin (1958) is given as follows:

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

Where Y_i* is censored variable.

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

$= Y_i^*$ *if* $Y_i^* > 0$

$$Y_i^* = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \cdots \ldots + \beta_n X_n + \varepsilon_i$$

..... (7)

Where:

Y_i* = TFP index of i^{th} 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; and ε_i = Error term

3 RESULTS AND DISCUSSIONS

3.1 Measuring Total Factor Productivity (TFP) of Sugarcane Famers in the Studied Area

The results showed that almost half (49.5%) 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 in order to maximize their output in sugarcane production in the studied area.

Table 1: *Distribution of Total factor productivity indices of farmers in Kwara State*

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**	
CV	**0.3871**	

Source: Field Survey, 2018

3.2 Determinants of TFP of Sugarcane Farmers in the Studied Area

The significance of the Chi^2 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 have the significant influence on the explained variable (Table 2). In addition, the diagnostic test of the model showed the absence of 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 Chi^2 test statistic which is within the radius of 10% degree of freedom. Though, 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 labour and land; yield and idiosyncratic variables: education, non-farm activities, extension contact, sickness of 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 labour coefficient means that both the free labour and the complemented labour (hired) were in excess, thus decreasing TFP of sugarcane producers in the studied area. However, the reasons for excess labour used may be attributed to the availability of family labour which is at free cost and cheap cost of hired labour whose reward is mostly in kind. The marginal and elasticity implications of a unit increase in the sucker, NPK, family labour and hired labour 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 TFP of sugarcane farmers in the studied area. If price received by the farmers is remunerative or farmers' term of trade is favourable, 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 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 been educated will increase TFP of sugarcane production by 0.0029 and 0.026% respectively. The positive effect of non-farm income on TFP implies that farmers with 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 household with health challenges would have decline TFP as medical consumption will affect the income stream or capital base of the farm investment. Also, the labour 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 of extra labour for strenuous/tedious farm operation will further deplete the capital investment of the farm, thus affecting the sugarcane farmers' TFP. Infact, the dearth consequences of ill health of farm family member are enormous, thus cannot be over-emphasized. The marginal and elasticity of TFP of sugarcane farmer with sick family member 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 age coefficient showed that the decline in labour efficiency of old farmers tends to decrease TFP of sugarcane. The negative coefficient of experience indicates conservative attitudes of experienced farmers towards innovations, thus 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 decline 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 social and 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 household composed of able-bodied people had high TFP in sugarcane production which is attributed to decrease in the cost of labour and increase in the farm capital investment which 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 Kwara State*

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

4 CONCLUSION AND RECOMMENDATIONS

Based on the findings it can inferred that farmers' TFP is affected by working capital which is due to excess supply, sickness and income in the studied area. In addition, almost half of the sampled population recorded productivity below the optimal level, an indication of inefficiency in the rationalization of their farm resources. Therefore, the study recommends that farmers should create alternative opportunities in which excess of the human labour could be channeled into, 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 need to strengthen the health institutions in the studied area by the government, non-governmental organization and the farmers, as 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. Incorporation of these recommendations will help to reduce importation of sugarcane, revitalization of sugarcane industrialization and revitalization of the rural economy in the studied area in particular and the country in general.

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