AMERICAN JOURNAL OF ENVIRONMENTAL ECONOMICS (AJEE)

ISSN: 2833-7905 (Online)

VOLUME 2 ISSUE 1 (2023)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Environmental Economics (AJEE)

Volume 2 Issue 1, Year 2023
ISSN: 2833-7905 (Online)
DOI: https://doi.org/10.54536/ajee.v2i1.1155
https://journals.e-palli.com/home/index.php/ajee

Determinants of Technical Inefficiency in Wheat Production: An Application of the Stochastic Frontier Model - Nigeria

Bashir A. B[1*], I.M Ali[2], Togun O. M[1], S.A Jibrin[3]

Article Information

Received: January 03, 2023
Accepted: March 07, 2023
Published: May 09, 2023

Keywords

Determinants, Technical, Inefficiency, Wheat, Production, Nigeria

ABSTRACT

This study examined wheat farming technical efficiency, its determinants and wheat production constraints among wheat farmers in the wheat producing states of Nigeria. The study did not cover Borno and Yobe wheat producing states due to volatile insecurity situation in the areas. Primary data were obtained from 866 farmers using proportionate selection from the states list of farmers. A structured questionnaire and interview schedule were administered to the farmers to collect data for the study. A Stochastic frontier model was used to capture wheat production efficiency and its determinants while, Likert scale was employed to reveal severity of wheat production constraints among farmers in the study area. Land size, quantity of seed planted, quantity of NPK fertilizer applied, quantity of Urea fertilizer applied and labour used in man-day were found to be positive and statistically significant. The most severe constraints affecting wheat production in the study area were poor access to credit, lack of dependable wheat market outlay, and access to improved and quality seed among others. There should be adequate incentives (timely supply of improved wheat seed, fertilizer and irrigation facilities at affordable prices.

INTRODUCTION

Wheat is a global staple food usually process into wheat-based foods (flour noodles, semolina pasta, and biscuit wheat meal), beer, beverages and animal feed. Many developing countries including Nigeria are facing challenges of low output, productivity and constrained input supply patterns. Wheat is one of the most important agricultural commodities in Nigeria that needs accelerated local production as a result of population growth. Nigeria produced approximately 60, 000 MT of wheat in 2016 worth $12.66 Million (only 0.004% of the global production) (Klynveld, Peat, Marwick and Goerdeler (KPMG, 2016; Proshare, 2018). In 2020, Nigeria imported $2.15B in Wheat, becoming the 4th largest importer of Wheat in the world (National Bureau of Statistics (NBS, 2022 and the Observatory of Economic Complexity (OEC, 2022). The surging wheat import could be attributed to the supply gap in the country and improved demand in the domestic market. This could be as a result of technical inefficiency of wheat farmers that need to be measured, since it provides information as to whether or not wheat farmers are producing a given quantity of output using minimum quantity of inputs (Oyekanmi, 2022)

Although, many studies have been conducted on technical efficiency of wheat farmers in other parts of the world(Anatolia in Turkey, Bihar in Indian, South Wollo in North-Central Ethiopia by Alender & Oren (2006), Prafulla (2012) and Hassen (2016) respectively), in Nigeria, studies carried out on technical efficiency focused on crops other than wheat. For example, Mukhtar *et al.* (2018) employed Data Envelopment Analysis (DEA) to determine technical efficiency of small holder pearl millet farmers in Kano state. However, no study has estimated technical efficiency of wheat production, its determinants along with challenges domicile in wheat producing states of the country. Hence the main focus of this study is to determine the inefficiency status of Nigerian wheat farmers.

METHODOLOGY

The study was conducted in wheat growing zones of Nigeria that comprised northern states of the country which lies between latitude $10^0 26/$N to $10^0 55/$ of the equator and longitudes $12^0 26/$E to $13^0 45/$ of the Greenwich Meridian. The climate of the area is tropical with distinct wet and dry seasons. The area experience 4-6 months of rainfall with a mean annual rainfall of about 1000mm-1500mm. The mean annual temperature is 26.3^0C. Majority of the people are full time farmers with a good number engaged in wheat farming. The major crops cultivated along with wheat are: sorghum, maize, groundnut and millet. Animal such as cattle, sheep, goat and poultry are also kept at both subsistence and commercial levels.

Sampling Technique

Samples were drawn from five out of seven wheat producing states of Nigeria which include: Kano, Bauchi, Jigawa, Kebbi and Sokoto. Borno and Yobe states were excluded because of the security challenges. The study considered 866 sample farmers from sample frame obtained from the states Association of Wheat Farmers. These samples were proportionally selected from the above list.

Analytical Tool

The study employed the use of stochastic frontiermodel

[1] Department of Agricultural Economics and Extension, Lake Chad Research Institute, Maiduguri, Nigeria
[2] Department of Agricultural Economics, University of Maiduguri, Nigeria
[3] Departmentof Agricultural Economics and Extension Borno State University, Njimtilo, Nigeria
[*] Corresponding author's e-mail: bashir5880@gmail.com

(SFM) to estimatetechnical efficiency of wheat production and its determinants among wheat farmers in Nigeria.

Model specification:

$InY_i = \beta^1 x_i + v_i - u_i$

Y_i = Wheat yield

β^1= Estimated Input parameters

v_i = Random noise term ($v_i \sim N(0,\sigma^2 v_i)$)

u_i = Technical inefficiency

Cobb Douglas Production Form

$InY_i = \beta_0 + In\beta_1 X_1 + In\beta_2 X_2 + In\beta_3 X_3 + In\beta_4 X_4 + In\beta_5 X_5 + v_i - u_i$

Y= Wheat yield (kg/farm)

X_1= land size (hectare)

X_2= seed planted (kg/ farm)

X_3= NPK fertilizer used (kg/ farm)

X_4= Urea fertilizer used (kg/ farm)

X_5 = Labour (man-day/ farm)

RESULTS AND DISCUSSION

The result from table 1 revealed how land size (Lnlperhact), quantity of seed planted (Lnseedq4planted), quantity of NPK fertilizer applied (Lnfertilizerq3a), quantity of Urea fertilizer applied (Lnfertilizerq3b) and labour used in man-day (Lnmanday2) influence wheat yield (Lnyield) across the study area. The parameter estimates showed positive signs all through which indicated direct relationship between wheat yield and its determinants. An increase in land size by one hectare will increase wheat yield by 0.2828kg which is statistically significant at 1%. Roersma (1997) findings was consistent with the result that farm size and labour price ratio positively correlated with high yield for the small farmers land and labour price ratio and lower for the larger farms, resulting in more intensive cultivation (more family labour per unit of land) and higher output per unit area than on larger farms. Moreover, most of the respondents cultivates wheat on small scale, but devoted to cultivating other crops such as rice, groundnut, and cowpea among others on a large scale. A unit increase in labour use will result to an increase in wheat yield by 0.1845kg which is statistically significant at 1%. This suggests that labour surpluses on smaller farms permit more labour to be used per hectare to care for crops and generate higher yields. More so, additional one kg of NPK or one kg of Urea fertilizer use by respondent will increase wheat yield by 0.4008kg and 0.1726kg respectively both of which are statistically significant at 1%. This result is also in line with Lachew *et al.* (2008) that fertilizer is positively correlated with value of yield at 1% level of significance. This implies that yield is likely to increase with increase in a kg of fertilizer applied. In other words, wheat production performance could be said to be dependent on NPK and Urea fertilizer applied as recommended. This could be the reason why, NPK and Urea fertilizer are applied together alongside with wheat seed at planting before second application as at when due. Furthermore, a unit increase in wheat seed planted will result to an increase in wheat yield by 0.0640kg and it is statistically significant at 10%. This may suggests that wheat farmers across wheat producing areas might be planting wheat seed below the recommended rate and therefore need to increase the rate of seed planting to be more efficient in production.

More importantly, the statistically significant at 1% (Prob < = z = 0.000) from truncated normal result in testing the null hypothesis (H_0=there is no inefficiency component) implies that we reject the null hypothesis (H_0) and conclude that inefficiency component exist

Table 1: Stochastic Frontier Normal Truncated-Normal Model Table

Lnyield	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
Lnlperhact	0.2828***	0.0356	7.94	0.000	0.2130	0.3526
Lnseedq4planted	0.0640*	0.0368	1.74	0.082	-0.0081	0.1362
Lnfertilizerq3a	0.4008***	0.0482	8.32	0.000	0.3064	0.4952
Lnfertilizerq3b	0.1726***	0.0447	3.86	0.000	0.0850	0.2602
Lnmanday2	0.1845***	0.0254	7.26	0.000	0.1347	0.2344
Const	3.6700***	0.2266	16.19	0.000	3.2258	4.1142

*Source: Field Survey, 2019. *** Significant at 1%, ** significant at 5%,* significant at 10%*

The average predicted inefficiency (U) estimated was 0.4969 or 49.69% with minimum and maximum technical inefficiency equals 0.0907 and 3.3114 respectively. This implies that close to half of the entire respondents are technically inefficient in wheat production in the study area. Hence Tobit regression was used to determine factors that influence technical inefficiency among wheat farmers in the study area after validating regression assumptions. The post estimation result test table 3 shows that there is no problem of multicollinearity, no

Table 2: Predicted Inefficiency

Variable	Observation	Mean	Std. Dev.	Min	Max
Predictedinefficiency(U)	830	0.4969	0.4106	0.0974	3.3114

Source: Field Survey, 2019

specification problem, no influencial observations, but there is appropriate functional form and the residual are not normally distributed. The heterokedasticity problem from the table was corrected with robust standard error. It should be noted that the test pass majority of the model assumption thereby confirming the reality of the result.

Table 3: Regression Assumption Test Table

Regression assumptions	Test	We seek values
Hesterokedasticity problem	**Breusch-Pagan hettest**	> 0.05
	Chi2(1): 4.732	
	p-value: 0.030	
No multicollinearity problem	**Variance inflation factor**	< 5.00
	Lnfertilizerq3a : 2.44	Mean VIF | 1.81
	Lnfertilizerq3b : 2.44	
	Lnseedq4planted : 1.62	
	Lnlperhact : 1.44	
	Lnmanday2 : 1.13	
Residuals are not normally distributed	**Shapiro-Wilk W normality test**	> 0.01
	z: 8.001	
	p-value: 0.000	
No specification problem	Linktest	< 5.00
	t: 0.320	
	p-value: 0.749	
Appropriate functional form	**Test for appropriate functional form**	> 0.05
	F(3,821):2.142	
	p-value: 0.093	
No influential observations	**Cook's distance**	< 1.00
	no distance is above the cutoff	

Source: Field Survey, 2019

The major constraints identified by respondents in the study area according to level of severity in table 4 include: poor access to credit (40.07%), lack of dependable market (39.49%), poor access to improved and quality seed (36.95%), high cost of fertilizer (39.61%), lack of proper germplasm wheat material (32.25%), poor utilization of local wheat /preference of imported wheat to local wheat (30.25%) which are the more severe

Table 4: Constraints to Wheat Production Across Wheat Producing Area

S/N	Constraints	Not Severe (%)	Least Severe (%)	Moderately Severe (%)	Severe (%)	More Severe (%)	Most Severe (%)
1	Lack of dependable market system	0.35	13.51	11.09	10.05	25.52	39.49
2	Poor utilization of local wheat/preference of imported wheat to local wheat	1.15	6.24	15.24	20.55	30.25	26.56
3	High Energy cost for wheat irrigation	2.77	9.58	18.24	34.53	21.59	13.28
4	Poor access to credit	0.92	4.39	7.62	8.43	38.57	40.07
5	Pest and disease infestation	1.15	9.82	24.13	32.22	17.90	14.78
6	Lack of functional wheat-based farmers association	7.04	10.39	24.25	25.17	20.44	12.70
7	Lack of capacity building for extension staff and farmers	3.58	11.20	26.44	23.79	18.36	16.63
8	Lack of proper germ plasm wheat materials	4.97	10.74	15.94	15.24	32.22	20.90
9	Poor access to improve and quality seed	3.12	9.12	11.89	23.21	15.70	36.95
10	High fertilizer prices	1.27	4.04	9.82	9.24	39.61	36.03
11	Non availability of fertilizer at required time	7.62	12.70	17.55	25.98	16.97	19.17
12	Non availability of farm labour	7.74	34.76	21.25	16.17	12.47	7.62

Source: Field Survey, 2019

constraints in wheat production. Severe constraints are high energy cost for wheat irrigation (34.53%), pest and diseases infestation (32.22%), lack of functional wheat-based farmers association (25.17%) and non-availability of fertilizer at required time (25.98%). Furthermore, lack of capacity building for the extension staff and farmers (26.44%) stands moderately severe in the study area, while non-availability of farm labour as at when due (34.76%) is least severe.

CONCLUSION AND RECOMMENDATION

The study concluded that about 50% technical inefficiencies existed among wheat farmers across the study area. Those inefficiencies determinants variables considered negatively correlated with wheat technical inefficiency. The major constraint affecting wheat production in the study area according to their level of severity includes; poor access to credit, lack of dependable market, and poor access to improve and quality seed among others. Hence the study recommended the following:

1. There should be training and retraining of more wheat farmers to reduce technical inefficiency among wheat farmers across the study area.
2. There should be adequate incentives (increased supply of improved wheat seeds at affordable price, increase supply of fertilizer at subsidized price, provision of standard irrigation facilities) for wheat farmers.
3. Agro Seed companies should invest in wheat seed multiplication in order to make it available and accessible to wheat farmers.
4. To boost wheat production in the study area, the itemized constraints should be immediately addressed.

REFERENCES

Alemder, & Oren, M. C. (2006). Measurement Technical Efficiency of wheat production in southeasthern Anatolia with parametric and non parametric methods. *Parkistan Journal of Biological Sciences, 9,* 6.

Baba, S. U., & Horst, D. V. (2018). Intra household relations and entitlement of land and livestock for women in rural Kano, Northern Nigeria. *Journals environments, 5*(2), 26. https://doi.org/10.3390/environments5020026

Balogun O. L. and B. E. Akinyemi (2017). Land fragmentation Effects on Technical Efficiency of cassava farmers in South-West Geopolitical Zone, *Nigeria Cogent Social Science, 3,* 1-10

Hassen B. (2016). Technical Efficiency Measurement and their Differential in wheat production: The case of smallholder farmers in south wollo. *International Journal of Economics Business and Finance, 4,* 1-16. https://oec.world/en/profile/hs/wheat

Jothan Momba. (2012). A Publication of the Southern African Institute for Policy and Research: *Zambia Social Science Journal, 3*(1), 19

KPMG [Klynveld, Peat, Marwick and Goerdeler] (2016). Wheat based consumer foods in Nigeria. https://home.kpmg/ng/en/home/insights/2016/08/wheat-based-consumer-foods-in-nigeria.html.

Lachew A. W., Loulseged S. B, and Yilma, A. D (2008). Impact of irrigation on poverty and environment in Ethopia. Draft proceedings of the symposium and exhibition held at Ghion Hotel, Addis Ababa, Ethopia, 240.

Mukhtar U., Mohamed Z. Shamsudin M.N., Sharifuddin J. (2018). Application of data envelopment analysis for technical efficiency of small holder pearl millet farmers in Kano state, Nigeria. *Bulgerian Journal of Agricultural science, 24*(2), 213-222.

Oyekanmi, S. (2022). Nairametrics. Muck Rack. Publication 2020.

Prafulla C. J. (2012). Technical efficiency of wheat production in Bihar : A regional Analysis A master thesis submitted to the department of Mathematics and Statistics Jawaharal Nahru Krishi Vishwa Vidyalaya, Jabalpar Collage of Agriculture. 80

Proshare Economy. (2018). Improved Wheat Production: An aid to Nigeria's diversification strategy. https://www.proshareng.com/news/COMMODITIES/Improved-Wheat-Production--An-Aid-to-Nigeria%E2%80%99s-Diversification-Strategy/39427.

Rahman, S., & Hasan, M. K. (2008). Impact of environmental production conditions on productivity and efficiency: A case study of wheat farmers in Bangladesh. *Journal of environmental management, 88*(4), 1495-1504.

Roersma H.P., (1997). Farm Classification: Analysis of production and income variation, Atlantic Zone Costa Rica, Research Programme on Sustainability in Agric (REPOSA) Phase 2 Report 116, 38.

Shaheem A. (2003). Competitiveness and efficiency in poultry and pig production in Vietnam Interational Livestock Research Institute working paper 57, 35.

Shanmugam K. R. and Kumar K. S. (2003). Environment and Development: Essays in Honour of Dr. U. Sanker 431.

Tan, shuhao, Nico Heerink, Arie, Kuyvenhoven and Futian Qu. (2010). Impact of land fragmentation on Rice Producers Technical Efficiency in South-East China. *NJAS-Wageningen Journal of Life Science 57,* 117-123.

The Observatory of Economic Complexity (OEC) (2021). Wheat. Retrieved on May 09, 2022. https://

oec.world/en/profile/hs/wheat