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Determinants of Productivity Among Smallholder Soybean Farmers In Federal Capital Territory and Kaduna State, Nigeria

Nijerya'nın Federal Başkent Bölgesi ve Kaduna Eyaletindeki Küçük Soya Fasulyesi Çiftçileri Arasında Üretkenliğin Belirleyicileri

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DETERMINANTS OF PRODUCTIVITY AMONG SMALLHOLDER SOYBEAN FARMERS IN FEDERAL CAPITAL TERRITORY AND KADUNA STATE, NIGERIA

ABSTRACT

This research study focused on determinants of productivity among smallholder soybean farmers in Federal Capital Territory and Kaduna State, Nigeria. A multi-stage sampling design was employed, in the fourth stage a proportionate and random sampling technique was used to select 200 soybean producers. The sampling frame approximately 400 soybean producers. The data were evaluated using descriptive statistics, stochastic production frontier model, and Kendalls' coefficient of concordance. The result shows that the mean age of soybean producers was 43 years (SD = 6.07). The soybean producers are small-scale farmers with an average of 1.45 (SD = 0.71) hectares of soybean farms. Averagely, the soybean producers had 15 years (SD = 5.12) of experience in soybean farming. The labour, farm size, fertilizer usage, seed, and agrochemicals were significantly different from zero in influencing productivity among smallholder soybean farmers. The major challenges faced by soybean producers include lack of improved seeds (1^{st} , $\bar{x}$=10.92), lack of credit (2^{nd}, $\bar{x}$=10.76), lack of farm technology(3^{rd} , $\bar{x}$=10.56), and high cost of fertilizer (4^{th}, $\bar{x}$=9.50). The study recommends that credit at single-digit interest rate be giving to soybean farmers to increase productivity. Also, farm technologies and farm inputs such as improved seeds, fertilizers and agrochemicals should be giving to soybean producers at appropriate time an affordable price.

Keywords: Productivity, Smallholder Soybean Producers, Stochastics Production Friontier Model, Kendalls' Coefficient of Concordance.

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NİJERYA'NIN FEDERAL BAŞKENT BÖLGESİ VE KADUNA EYALETİNDEKİ KÜÇÜK SOYA FASULYESİ ÇİFTÇİLERİ ARASINDA ÜRETKENLİĞİN BELİRLEYİCİLERİ

ÖZ

Bu araştırma çalışması, Nijerya'nın Federal Başkent Bölgesi ve Kaduna Eyaletindeki küçük soya fasulyesi çiftçileri arasındaki verimliliğin belirleyicilerine odaklandı. Çok aşamalı bir örnekleme tasarımı kullanılmış, dördüncü aşamada 200 soya fasulyesi üreticisini seçmek için orantılı ve rastgele örnekleme tekniği kullanılmıştır. Örnekleme yaklaşık 400 soya fasulyesi üreticisini kapsamaktadır. Veriler, tanımlayıcı istatistikler, stokastik üretim sınırı modeli ve Kendalls'ın uyum

katsayısı. Sonuç, soya fasulyesi üreticilerinin ortalama yaşının 43 (SD = 6,07) olduğunu göstermektedir. Soya fasulyesi üreticileri, ortalama 1,45 (SD = 0,71) hektar soya fasulyesi çiftliğine sahip küçük ölçekli çiftçilerdir. Soya fasulyesi üreticilerinin soya fasulyesi çiftçiliğinde ortalama 15 yıllık (SD = 5,12) deneyimi vardı. İşgücü, çiftlik büyüklüğü, gübre kullanımı, tohum ve tarım kimyasalları, küçük soya fasulyesi çiftçileri arasında üretkenliği etkileme açısından sıfırdan önemli ölçüde farklıydı. Soya fasulyesi üreticilerinin karşılaştığı en büyük zorluklar arasında iyileştirilmiş tohum eksikliği (1., $\bar{x}$=10.92), kredi eksikliği (2., $\bar{x}$=10.76), çiftlik teknolojisinin eksikliği (3., $\bar{x}$=10.56) ve yüksek maliyet yer alıyor. gübre (4. , $\bar{x}$= 9.50). Çalışma, verimliliği artırmak için soya fasulyesi çiftçilerine tek haneli faiz oranıyla kredi verilmesini öneriyor. Ayrıca, gelişmiş tohumlar, gübreler ve tarımsal kimyasallar gibi çiftlik teknolojileri ve çiftlik girdileri, soya fasulyesi üreticilerine uygun zamanda ve uygun bir fiyatla sunulmalıdır.

Anahtar Kelimeler: Üretkenlik, Küçük Toprak Sahibi Soya Fasulyesi Üreticileri, Stokastik Üretim Sınır Modeli, Kendalls Uyum Katsayısı.

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1. INTRODUCTION

Compared Soybean (*Glycine max*) ranks third next to wheat and rice in world cereal production (Girei et al., 2018). It is the world most important oilseed legume with respect to international trade and total production (Biam et al., 2016). Soybean based foods are becoming increasingly common in sub-Saharan Africa (SSA) (Kolapo 2011). In Nigeria, there is an increase in soybean consumption among low income groups that naturally cannot afford the expensive sources of protein such as fish, meat, and eggs. Soybean provides a high and cheaper protein rich alternative substitute to animal protein (Samuel and Idris, 2021). The importance of soybean ranges from oil processing, milk production, medical, livestock feed, human and industrial consumption, and recently, as a source of bio-energy (Omoigui et al., 2020). Soybean is used in the formulation of poultry feed due to its high protein content (40% protein content), and it is also a significant source of income which is grown for its protein and oil content (Joubert and Jooste, 2013). Globally, soybean is one of the major sources of healthy vegetable oil recommended and recognized by the nutritionists, it is an affordable and nutritious meal for malnourished nursing mothers and children (Khojely et al., 2018; Dugje et al., 2009). It is rich in protein, fibre and has low cholesterol. Soybean is grown in almost every state in Nigeria with a higher concentration in the Northern states, with the North Central and North West zone accounting for approximately 97% of production (USAID 2016). The major producing states are Kaduna Benue, Taraba, Kano, and Nasarawa States (NAERLS, 2013). The soybean can contribute to improving soil

fertility through nitrogen fixation, permitting a longer duration of ground cover in the cropping sequence, and provide useful crop residues for feeding livestock, the haulms provide good feed for goats, sheeps, and controls the parasitic weed (Saliu et al., 2017). The Nigeria's low soybean yield can be attributed to the use of low-yielding varieties, the sparing use of fertilizers, and inconsistence government policies to subsidize the production of this crop (Khojely et al., 2018). Nigeria is the second largest producer of soybean in sub-Saharan Africa and ranks twelfth (12^{th}) position in the world with a production of 1.06 million tons in 2022 (FAO, 2024). The output of soybean in Nigeria and the world in 2021 and 2022, respectively is shown in Table 1. Nigeria produces approximately 0.313% and 0.304% of the world soybean output in 2021 and 2022, respectively (FAO 2024). Similarly, the soybean cultivated area (hectares) in Nigeria and the world in 2021 and 2022, respectively is shown in Table 2. There is low output of soybean in Nigeria which is caused by several factors, low productivity, high risk soybean farming, low income from soybean farming, traditional method of soybean farming slow adoption of production technology (Daramola et al., 2019). The demand-supply gap of soybean will soon reach an exponential level because of increasing series of environmentally sustainable products that are derivable from its processing (NEPC, 2010). The Nigeria domestic production of soybean still lags behind the rapidly growing demand from the poultry industry for soybean meal and vegetable oil processors because of poor post-harvest and agronomic practices and low yield. (USAID 2016). There is a domestic annually shortfall of about 100,000 tons for soybean meal, and approximately 300, 000 tons for vegetable oil (USAID, 2016).

Table 1. The Output of Soybean in Nigeria and the World

Variables	Output of Soybean in Nigeria (tons)	World Output of Soybean (tons)
Output of Soybean in 2021	1166050	372853696.71
Output of Soybean in 2022	1060000	348856427.48

Source: FAO (2024)

Table 2. The Soybean Cultivated Area in Nigeria and the World

Variables	Area of Soybean in Nigeria (Hectares)	World Area of Soybean (Hectares)
Soybean Area in 2021	1105950	130477261
Soybean Area in 2022	1100000	133791633

Source: FAO (2024)

1.1 Research Questions

This study provided answers to the following research questions:

(i)What is the farm and farmers' characteristics among soybean producers?

(ii)What are the factors influencing the productivity among soybean farmers?

(iii)What are the challenges facing the soybean producers in the study area?

1.2 Objectives of the Study

The major aim of the research is focused on the determinants of productivity among smallholder soybean farmers in Federal Capital Territory and Kaduna State, Nigeria. Specifically, the objectives were states as to:

(i) describe the farm and farmers' characteristics among soybean producers,

(ii) evaluate the predictors influencing the productivity among soybean farmers,

(iii) determine the challenges faced by soybean producers

1.3 The Hypotheses of the Study

This study provided answers to the following null-hypotheses:

$H0_1$: There is no significant relationship between the selected independent variables (labour, farm size, fertilizer usage, seed, and agrochemicals) and productivity among soybean producers.

$H0_2$: There is no significant difference between the challenges facing soybean producers.

MATERIALS AND METHODS

This study was carried out in Federal Capital Territory and Kaduna State, Nigeria. A multi-stage sampling design was utilized, at the fourth stage, a proportionate and simple random sampling technique was used to select 200 soybean producers. The sample frame of soybean producers approximately 400 respondents. The total sample number of soybean producers consists of 100 soybean producers from Federal Capital Territory and Kaduna State, respectively. Primary data of cross-sectional sources were used based on a well-designed questionnaire that was subjected to validity and reliability test. This sample number was estimated based on the established formula of Yamane (1967) as follows:

$$n = \frac{N}{1+N(e)^2} = \frac{400}{1+400(0.0025)} = 200 \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

n = The Sample Number

N = The Total Number of Soybean Producers (Number)

e = 5%

The data obtained were analyzed using descriptive statistics, stochastic production frontier model, and Kendalls' coefficient of concordance:

2.1 The SPEFM (*Stochastic Production Efficiency Frontier Model*)

According to Alabi et al. (2022), the SPEFM is stated thus:

$$Y_i = f(X_i, \beta_i) e^{v_i - u_i} \quad (2)$$

$$Ln\, Y_i = Ln\, \beta_0 + \sum_{j=1}^{5} \beta_i\, Ln X_i + (v_i - u_i) \quad (3)$$

$$TE_i = \frac{Y_i}{Y_i^*} \quad (4)$$

$$TE_{ij} = \frac{F(X_i, \beta) \exp(v_i - u_i)}{F(X_i, \beta) \exp(v_i)} v \quad (5)$$

$$TE_{ij} = \exp(-u_{ij}) \quad (6)$$

where,

Y_i = Output of Soybean (Kg)

Y_i^* = Unobserved Frontier Output of Soybean (Kg)

X_i = Inputs

β_i = Vectors of Estimated Parameters

V_i = Random Variations

U_i= Error Term due to TIE (Technical Inefficiency)

X_1 = Labour (Mandays)

X_2 = Farm Size (Ha)

X_3 = Fertilizer Usage (Kg)

X_4 = Seed in Kg

X_5 = Agrochemicals (Litre)

2.2 Kendalls' Coefficient of Concordance (W)

The Kendalls' Coefficient of Concordance (W) is stated below:

$$W = \frac{12S}{m^3(n^3-n)-mT} \quad (7)$$

Where:

n = Number of Attributes or Objects that is Evaluated by Respondents

m = Number of Respondents

S = Sum Overall Subjects

T = Correction Factor estimated for Tied Ranks

$$T = \sum_{k=1}^{g}(t_k^3 - t_k) \quad (8)$$

Where;

t_k = Number for Tied Ranks for each (k) in 'g' Groups of Ties

Friedmans' Chi Square ($\chi 2$)

$$\chi 2 = m(n-1)W \quad (9)$$

3. RESULTS AND DISCUSSION

3.1 The Farm and Farmers Characteristics of Soybean Producers

The farm and farmers' characteristics of soybean producers is presented in Table 3. The soybean producers were 42 years of age. This signifies that they are young, resourceful, and they can easily adopt innovations, new ideas, farm technologies, and research findings. This outcome is supported with findings of Oluwafemi et al. (2022) who obtained the mean age of 40 years among soybean farmers in Oyo State, Nigeria. According to Girei et al. (2018) who reported that age has an important impact on the perspective and judgement of producers relative to adoption of new and improved innovative technologies, risk aversion, and other farm production-related decisions. The producers were found to own a mean farm size of 1.45 hectares of soybean farms. The outcome shows that the soybean producers were predominantly smallholder farmers based on the classification of farm holdings in Nigeria by Olayide (1980) who reported that small, medium, and large scale producers hold 0.1 – 5.99, 6.0 – 6.99, and above 10 ha, respectively. The producers had about 15 years' experience in soybean farming with standard deviation of 5.12. This result is supported with outcome of Saliu et al. (2017) who reported that the number of years' experience in farming determines the producers' ability to make effectively farm management decision not only to adhere to agronomic practices

but also with respect to resource allocation or input combinations. They attended formal education and are literate, can read and write with average of 15 years (SD = 5.12) of attending school education. According to Girei et al. (2018), educations is a key socio-economic factor that affect producers' decision because of its effect on the perception, awareness, reception, and quick processing and adoption of innovation that led to efficient farm management and improved productivity. The large household size is a source of unpaid family labour for soybean farming activities. The household sizes were large with average of 14 people per household. This finding is supported with results of Olorunsanya et al. (2009) who reported that large families appeared to save more extra cost for hiring labour than small families. In this study, labour was measured in terms of adult mandays as eight hours per day. The mandays for both family and hired labour were calculated. Operations performed by women were taken to be 0.75 of the mandays equivalent, and those by children to be 0.50 (Saliu et al., 2017). The mean mandays of soybean producers is 69 mandays with standard deviation of 1.39. This result is supported with findings of Saliu et al. (2017) who obtained an average of 56 Mandays for soybean farmers in Kaduna State, Nıgerıa. The fertilizer usage is the amount of inorganic fertlizer used for the production of soybean. It is included in the model to examine the extent to which the variability in quantity of this inorganic fertiizer used influence the yield. The mean quantity of fertilizer used by the soybean producers is 250 kg ha^{-1} standard error of 20.86.The everage quantity of fertilizer used was low compared to 275 kg ha^{-1} recommended by IITA (2009). The relative importance of seed in crop production cannot be over-emphasized. The increase in soybean output can be more expereinced by increasing the seed both in quality and quantity. Table 3 shows that the mean of seed planted is 45kg ha^{-1} with standard deviation of 1.27. The average of seed planted was low compared to 50 – 70 kg ha^{-1} recommended by IITA (2009). The soybean becomes attractive to pod-sucking bugs that can reduce the seed quantity from flowering onwards.The insect pest can be controlled with agrochemicals. Table 3 shows that the mean quantity of agrochemicals used by soybean producers is 3.78 litre ha^{-1} standard deviation of 0.16.

Table 3: The Farm and Farmers Characteristics among Soybean Producers

Variables	Unit of Measurement	$\bar{X}_i$	SD
Age	Years	43	6.07
Farm Size	Hectare	1.45	0.71
Farming Experience	Years	15	5.12
Formal Education	Years	14	3.07
Household Size	Number	14	5.07
Labour	Mandays	69	1.39
Fertilizer Usage	Kilogram	250	20.86
Seed	Kilogram	45	1.27
Agrochemicals	Litre	3.78	0.16

Source: Field Survey (2024), SD-Standard Deviation

3.2 Descriptive Statistics of the Socio-Economic Characteristics and Challenges Encountered by Soybean Producers

The descriptive statistics of socio-economic characteristics and challenges encountered by soybean producers is presented in Table 4. About 92% (184) of soybean producers were married, while 8% (16) of respondents were either single. This result is in conformity with Aphunu and Otoikhian (2008) who stated that marital status is a key factor which is likely to encourage the sustainability of adoption decision. Approximately 89% (178) of soybean producers were male, while 11% (22) of the respondents were female. This outcome is supported with results of Noad and Bamlaku (2017) who reported that the field of agricultural farming is more dominated by male.Approximate 91% (SD = 0.49) are members of cooperative organization, while 9% (18) do not belong to any member of cooperative organization. The members of cooperative organization afford the soybean producers access to credit, share ideas and information, and sell their soybean produce in bulk. The major challenges (SD = 0.51) encountered by soybean farmers include lack of improved seeds (21%), lack of credit (20%), lack of farm technologies (14%), high cost of fertilizer (12%), poor access to extension services (10.50%), bad road network (5.50%), high cost of labour (5%), problem of insecurities (4.50%), price instability (4%), and high transportation cost (3.50%).This outcome is supported with results of Agada (2015) who reported that poor knowedge of improved production techniques, inaedequate training oppotunities for farmers, shortage of farm labour, lack of access to labour-saving technologies, low soil fertility, incidence of insect pests and diseases, and weak or non-existence of farmer groups are production constraints facing soybean farmers in Benue State, Nigeria.

Table 4: The Descriptive Statistics of Socio-Economic Characteritics and Challenges Encountered by Soybean Producers

Variables	Frequency	Percentage	SD
Marital Status			0.81
Married	184	92.00	
Single	16	08.00	
Sex			0.38
Male	178	89.00	
Female	22	11.00	
Membership of Cooperatives			0.49
Member	182	91.00	
Non-Member	18	19.00	
Challenges Encountered			0.51
Lack of Improved Seeds	42	21.00	
Lack of Credit	40	20.00	
Lack of Farm Technologies	28	14.00	
High Cost of Fertiizers	24	12.00	
Poor Access to Extension	21	10.50	

Services		
Bad Road Network	11	05.50
High Cost of Labour	10	05.00
Problem of Insecurities	9	04.50
Price Instability	8	04.00
High Transportation Cost	7	03.50
Total	200	100.00

Source: Field Survey (2024) SD – Standard Deviation

3.3 The Predictors Influencing the Productivity among Soybean Farmers

Table 5 presents the maximum likelihood estimates of the predictors influencing productivity among soybean producers using stochastic production efficiency frontier model (SPEFM). The estimated coefficients in the technical efficiency component fall between 0 and 1, thus all marginal products (MPs) are positive and declining at the mean of factors. This aligns with a priori expectations, this is supported by findings of Abdulai and Abdulahi (2016) who reported the significant and positive influence of frontier factors on output of maize producers in Zambia. The mean-TE (0.79) of 79%, this means that an average smallholder soybean producer in the sample needs about 21% additional inputs to get to the frontier, in other terms, a smallholder soybean producers lost on balance of 21 percent of produce due to technical inefficiency (TIE).

The partial derivatives are called the marginal product or the partial elasticity. The addition of first order partial derivatives of the output factors which is called the return to scale or scale efficiency shows the decreasing return to scale in the frontier model adding up to 0.8539. This connotes that increasing all factors by a certain proportion will give rise to a less than proportionate rise in output of the smallholder soybean producers.

The coefficient of labour as measured in man-days is positive (0.1452) and significant different from zero in raising the output of soybean at 5% probability level. This means that as labour increase by 1% while keeping all other factors fixed will give rise to 14.52% increase in output of soybean. This result is similar with findings of Asodina et al. (2021) who obtained a positive and significant relationship between labour and output of soybean among smallholder soybean farmers in Ghana.

The coefficient of farm size as measured in hectares is positive (0.2118), and statistically different from zero in raising the output of soybean at 5% probability level. This signifies that as farm size increases by 1% keeping other factors fixed will give rise to 21.18% increase in output of soybean. This is highlighted by Oyenpemi et al. (2013) who obtained 99.90% increase in output of soybean from 1% increase of farm size among smallholder farmers in Kwara state, Nigeria.

The coefficient of fertilizer used (0.1813) was positive and significant at 1% probability level. This means the higher the use of fertilizer, the more productive the soybean farmers become. This implies that when the soybean farmers adopt and use the fertilizer appropriately, it would lead to increased output. A 1% increase in fertilizer usage, while keeping all other factors fixed will give rise to 18.13% increase in productivity of soybean. This outcome is supported with findings of Samuel and Idris (2021) who obtained 92.23% increase in productivity from 1% increase in fertilizer usage among soybean farmers in Taraba State, Nigeria.

The coefficient of seed (0.1408) is positive and was significantly different from zero at 1% probability level in influencing the productivity among soybean farmers. The signifies that if quantity of improved seed used increased with required rate by 1%, while keeping all other factors fixed, will lead to 14.08% increase in productivity among soybean farmers. This finding is supported with outcomes of Wake et al. (2019) who obtained a 28.1% increase in productivity from a 1% increase in quantity of improved seed used among smallholder soybean producers in Western Ethiopia.

In the diagnostic statistics component, the coefficient of variance ratio (γ) also called gamma is 0.7432, this connotes that 74.32% of variations in the productivity among soybean farmers were due to differences in technical efficiency. Furthermore, this signifies that 74.32 % of random fluctuation in the yield of the soybean farmers were due to the producers' inefficiency. Therefore, reducing the influence of the effect of gamma or variance ratio will improve the output of soybean and greatly enhance the productivity of the farmers. The coefficient of total variance (σ^2) also called sigma square is 2.4572, which is statistically different from zero at 1% probability level. This means that the model used and data obtained were correctly specified. The LLF (Log-Likelihood function) is -538.57. The finding is supported with results of Wake et al. (2019) who reported that land, seed, fertilizer, labour, oxen, and agrochemicals had positive coefficients and were significant stimulus influencing productivity among soybean farmers in Ethiopia.

Table 5: The Predictors Influencing the Productivity among Soybean Farmers

Variables	Coefficient	Std. Error.	P-value
Labour	0.1452**	0.0558	0.027
Farm Size	0.2118**	0.0824	0.026
Fertilizer Usage	0.1813***	0.0464	0.000
Seed	0.1408***	0.0335	0.000
Agrochemicals	0.1748**	0.0705	0.045
Constant	2.429***	0.5662	0.000
RTS	0.8539		
Diagnostic Statistics			
δ^2	2.4572***		
Gamma	0.7432		
Log-Likelihood Function	-538.57		
Mean Efficiency Score	0.79		

Source: Field survey (2024)
*Significant at (P<0.10)., **Significant at (P<0.05), ***Significant at (P<0.01).

3.4 The Challenges Faced by Soybean Producers

The Kendall's coefficient of concordance was employed to explain the challenges faced by soybean producers. The challenges were ranked using numerals 1 to 10 utilizing four- point Likert scale from strongly agree to the strongly disagree and the result is presented in Table 6. The mean rank score for each challenge was computed and the challenge with the highest mean rank score was considered the first, while the challenge with the lowest mean score was considered the least. The lack of improved seed (mean rank score of 10.92) was considered the highest rank (1st), lack of credit (mean rank score of 10.76) was ranked 2nd, while the high transportation cost (mean rank score of 7.36) was considered the lowest rank (10th). The result further signifies that there were significance differences between the ranks of challenges which was tested at 1% level of probability. Therefore, the null-hypothesis (there is no significance difference among the challenges faced by soybean farmers) was rejected and alternative hypothesis was accepted. The Kendall's statistics of concordance (W) was estimated at 0.182, while the F-Critical is evaluated at 4.86 and F-Calculated was evaluated at 48.832. This finding is similar with the outcomes of Sadiq et al. (2021) who evaluated the constraints faced by rice farmers in Niger State, Nigeria using Kendall's coefficient of concordance (W) with an estimated value of 0.701 which was different significantly from zero at 1% probability level. This finding is in line with outcomes of Agada (2015) who reported that the lack of access to labour-saving technology unavailability and high cost of farm inputs, poor access to credit facilities, high cost of transportations and poor extension-farmers contacts were the constraints facing soybean farmers in Benue State Nigeria.

Table 6. The Challenges Faced by Soybean Producers

Constraints	Overall Rank	Mean Rank Score
Lack of Improved Seeds	1	10.92
Lack of Credit	2	10.76
Lack of Farm Technologies	3	10.56
High Cost of Fertilizers	4	9.50
Poor Access to Extension Services	5	8.42
Bad Road Network	6	8.37
High Cost of Labour	7	8.36
Problem of Insecurities	8	8.24
Price Instability	9	7.82
High Transportation Cost	10	7.36
Number of Observation	200	
Kendall's Coefficient (W)	0.182	
Chi Square	529.32	
df	9	
F-Critical	4.86	
F-Calculated	48.832	
Asymptotic Significance	0.0000	

Source: Computed from Field Data (2024)

4. CONCLUSION

This study focused on determinants of productivity among soybean farmers in Federal Capital Territory and Kaduna State, Nigeria. A multi-stage sampling technique was utilized, at the fourth stage, a proportionate and random sampling technique was used to select 200 smallholder soybean producers, the sample frame was estimated at 400 respondents. The primary data were used based on a well-designed questionnaire. The data were evaluated using descriptive statistics, stochastic production frontier model, and Kendalls' coefficient of concordance. The following conclusion were made based on the research questions:

What is the farm and farmers' characteristics among soybean producers?

The average age of soybean producers was 43 years. This finding is in support of results of Ezedinma and Ohi (2001), who reported that the average age of farmers in Nigeria is between 45 and 48 years, and that this age group forms the productive work force. The soybean producers are small-scale farmers with an average of 1.45 hectares of soybean farms. On the average, soybean producers had 14 years of school education, with 15 years' experience in soybean farming. This result agrees with findings of Ochepo (2010) who reported that about 92.8% of the rural people who are mostly farmers were educated at various levels. The household sizes were large, with an average of 14 people per household. According to Okoro et al. (2016) who affirmed that many farm families take advantage of their household sizes as farm labour to increase production and maximize profits.

What are the factors influencing the productivity among soybean farmers?

The coefficients of labour, farm size, fertilizer usage, seed, and agrochemicals were positive and significant different from zero in influencing the productivity among soybean farmers. This finding is supported with findings of Yegon et al. (2015) who obtained reported that farm size has a positive and significant relationship with soybean yield. This study also agrees with results of Ogunjinmi et al. (2016) who obtained a positive and significant relationship existed between labour and output of soybean. The mean technical efficiency was estimated at 0.79, leaving an inefficiency gap of 0.21 that needs to be filled. This could be done by effective extension- farmer relationship, training programmes, adequate and appropriate use of farm inputs. This work is similar to outcomes of Oyenpemi et al. (2023) who obtained mean technical efficiency of 0.56 and inefficiency gap of 0.44 among smallholder farmers in Kwara State, Nigeria. The sum of marginal productivities of factors under consideration gave an estimated return to scale of 0.8539, which signifies decreasing return to scale.

What are the challenges facing the soybean producers in the study area?

The challenges faced by soybean farmers include lack of improved seeds (1st, mean rank score = 10.92), lack of credit (2nd, $\bar{x}$ = 10.76), lack of farm technology (3rd, $\bar{x}$ = 10.56), and high cost of fertilizers (4th, $\bar{x}$ = 9.50). This study agrees with outcome of Samuel and Idris (2023) who identified high cost of fertilizers, high cost of seed, unavailability of labour, seasonal price variations scarcity of farm land as major challenges facing soybean farmers in Taraba State, Nigeria. This outcome is similar to result of Akinyemi et al. (2017) who have identified high cost of labour, herdsmen destructive activities, and pests and diseases as challenges faced by Nigerian farmers. The following suggestions were made:

(i) Credit at single-digit interest rate devoid of cumbersome administrative procedures should be provided for smallholder soybean farmers to increase productivity.

(ii) Extension officers should be employed to disseminate innovations, farm technologies, research findings to farmers.

(iii) Farm technologies, equipment, machines should be provided by public and private organizations for soybean farmers to increase productivity.

(iv) Farm inputs such as fertilizers, improved seeds, agrochemicals and other farm inputs should be provided for soybean farmers to increase productivity.

(v) Feeder roads should be constructed for easy evacuations of soybean produce to nearby centers.

(vi) Problem of insecurity and price instability should be addressed.

Conflict of Interest

The authors declare that there is no conflict of interest

Ethical Committee

This study does not require ethics committee approval

Author Contributions

Design of Study: AOO (50%), MI (50%), AJS (50%), MAA(50%), OA(50%),

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Data Analysis: AOO (50%), MI (50%), AJS (50%), MAA (50%), OA(50%),

Writing Up: AOO (50%), MI (50%), AJS (50%), MAA(50%), OA(50%),

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