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Performance and Profitability Analysis of Maize Production a Case of Smallholder Maize Farmers in Osun State, Nigeria

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Abstract: Maize is an essential agricultural produce in Nigeria because it enhances the welfare condition of the farmers as a source of income generation, as well as the provision of employment opportunities. However, despite the expected enormous benefits, some producers still find it difficult to take care of their immediate needs due to poor income. Hence, the study examined the factors influencing the profitability of maize farmers in Osun State, Nigeria. Primary data were collected using a well-structured questionnaire and 120 farmers were randomly selected from two out of the three Agricultural Development Program (ADP) zones in Osun State. Analytical methods employed were benefit-costs ratio and, ordinary least square (OLS) regression analyses. The results indicated the prevalence of female farmers in the study area, while average farmers' age was estimated at 45 years. The results also revealed that on the average, household size contains about 5 people, while the average years of farming experience was estimated at 13 years. The revenue to cost ratio analysis indicated that maize farming is profitable in the study area and that age, marital status, years spent in school, and the farm-size were significant determinants of maize farmer's income in the study area. The study recommended institutional supports for the farmers in the aspects of agricultural inputs subsidy, provision of technical know-how assistance and making credit facilities accessible and available to the farmers.

Keywords: performance, maize production, profitability, OLS, osun state.

1. Introduction

The importance of maize as grains in Nigeria lies in both its economic value and provision of food for human sustenance. According to Abdulaleem *et al.* (2017), about 50 species of maize exist with various colors, shapes, sizes, and textures. Maize has turned out to be the second-largest produced crop in the world, and in the sub-Saharan African (SSA) countries, most farmers predominantly focus on maize cultivation, alongside other arable crops for human consumption and sales (Santpoort, 2020). Maize has become an important crop in human diet, particularly in Nigeria. The crop and corresponding products from its value addition has the potential to alleviate food insecurity currently plaguing the country, with a potential to reduce poverty among the people. Maize is regarded as a desirable staple diet consumed by

more than 860 million people, approximately 150 million rural farming households, and about one-third of the undernourished across the globe (FAO, 2020; Murdia, Wadhwani, Wadhawan, Bajpai, and Shekhawat, 2016; Ranum, Wik, Pingali and Brocai, 2008), while in Nigeria, the cultivation of maize is dominated by smallholder farmers in the rainforest and the derived savannah zones of the country.

Many agro-based industries in Nigeria presently depend on maize as a raw material for their production (Onuwa, 2022; Olaniyan, 2015). Maize makes up a major share of the ingredient utilized in livestock feed formulation. In addition to that, ethanol which is used for bio-fuel and medicinal purposes is also a by-product of maize grains (Monsanto, 2014). Even though the crop is considered a grain, maize is also eaten as a vegetable, because the immature form of maize is an important source of vitamins A, C, and E and its mature form is a rich source of carbohydrate, essential protein, minerals, and dietary fibre (Mohammad *et al.*, 2014). All the usefulness presents maize as an important agricultural product that is very crucial to the growth and sustainability of Nigeria at large.

Given the above stated importance of agriculture, the global food system is faced with a lot of challenges impeding agricultural development and sustainable farm income, and the smallholder farmers suffer the consequences. Suffice it to say that smallholder farmers struggle to manage a complex set of risks and threats, which include input access barriers, fluctuations in the price of products, customary land tenure issues, and the negative impact of climate extreme events (Takahashi *et al.*, 2020). In addition, farming system is confronted with the lack of market access and information, high cost of production, limited use of improved technologies or discontinued use of improved technologies, high storage expenses, lack of finances, lack of gender-just agri-food policies, and unstable political environment, amongst many others. Consequently, productivity is impacted, food supply chain is disrupted, and farmers' income becomes unstable, and badly affected; evidently, all these are symptoms of food insecurity, and by extension poor state of farmers' well-being (Gebre *et al.*, 2021).

Conclusively, the production of maize is extremely important in terms provision of food, income generation, provision of raw materials for agro-allied and other industries along the food value chain, and employment opportunities for individuals. However, despite the window of opportunities available via its value chain, the index of unemployment, joblessness, and poverty among Nigerians remains alarming, which potentially constitute a challenge to the achievement of Sustainable Development Goals 1 (no poverty) and 2 (zero hunger). Therefore, these challenges necessitated the need to examine and interrogated the profitability trend of maize farming, as well as dynamics driving income generation among maize farmers in Osun State, Nigeria. To the best of our knowledge, there is paucity of this type of research in Osun State, despite the fact that related studies have been conducted in other areas (for instance, Otekhile and Verter, 2017; Ukagwu *et al*, 2014; Safa, 2005).

2. Materials and methods

2.1. Study area and data collection

This study was carried out in Osun State, Nigeria, with a land area of about 3,572 sqm. The climate is tropical, with abundant rainfall during the summers compared to the winter seasons. Every part of the state supports maize cultivation at least twice a year. Rainfall, temperature, and precipitation are the main climatic factors that controlled the agricultural activities of farmers in the study area (Adenegan *et al*. 2012). Primary data were collected for this study using a well-structured interview schedule. The study area is structured into three Agricultural Development Program (ADP) zones namely Osogbo zone, Iwo zone and Ife/Ijesa zone. Maize farmers were chosen from the three zones through a multistage random sampling procedure. First, two Local Governments Areas (LGAs) were selected in each of the zones. In the second stage, one village was chosen from each of the LGAs selected, while in the third stage, random proportionate to size sampling technique was applied to select 120 maize farmers from all the villages chosen, and this was the villages have different population size.

2.2. Analytical methods

Both descriptive and inferential statistics were applied to analyze the data collected from the farmers. The descriptive statistics made use of frequencies, percentages, mean values and standard deviation to describe the farmer's demographic and socio-economic characteristics. The respondent's level of profitability and farm feasibility was determined through the market margin of the maize farmers (income, total revenue, and total cost). The study also applied Ordinary Least Square (OLS) estimation technique as inferential statistics, to examine the factors influencing income generation among the maize farmers in Osun State, Nigeria.

2.3. Level of Profitability

The research variables included in the determination of the farmer's level of profitability include income or total revenue, variable costs, fixed costs, prices, yield, and unit price of produce. Following the standards of Nikoyan (2020), the feasibility of maize farming profitability in Osun State, Nigeria, being one of the country's leading agricultural commodities was computed using the benefits-cost ration analysis. The level of maize profitability, as well as farm feasibility, can be mathematically expressed as follows:

$$I=TR-TC \quad (1)$$

where:
I=Profit or Net income
TR=Total Revenue
TC=Total Cost

$$TR=Y.Py \quad (2)$$

where:
Y= Yield
Py =Price of Yield

TC=FC+VC (3)
FC=Fixed cost
VC=Variable cost
However, the farm feasibility can be found using the cost to ratio (R/C) analysis i.e.R/C = index of farm feasibility.
R/C=TR/TC (4)

Based on the criteria that:
IfR/C=1, farming is at break-even point (neither profitable or loss)
R/C<1= the farm is operating at loss (5)
R/C>1 = the farm is profitable (6)

2.4. Factors affecting maize farmer's profitability

The factors influencing the respondent's level of profitability (income)was evaluated using the OLS regression model. The method is suitablefor this study because it is a generic liner modeling procedure which can be used to simulate the dependent variables and a response. It gives a universal and best modeling variables for prediction. The theory of Ordinary Least Square regression model relies on the assumption that the explanatory variables are measured with a minimal, or no mistake and technique permit multiple or single independent variables to be used in the model (Sharma *et al*., 2013). In this study, the dependent variable (Y) is the level of profitability (income), while the independent variables range from $x_i$to x_9. The explanatory variables considered are gender, age, marital status, years of schooling, household size, membership of organization, access to credit, the farm size as well as years of farming experience. Furthermore, Seffrin *et al*., (2018) stressed that Ordinary Least Square (OLS) regression can be modeled to adjust the relationship between an independent variable and a set of dependent variables. Thus, the mathematical expressions of the OLS regression model, given the four functional forms (linear, semi-log, double-log, and exponential, respectively) considered, are expressed as:

$$Y = \beta_0 x_0 + \beta_i x_i + e_i$$

$$\ln Y = \beta_0 x_0 + \beta_i x_i + e_i \quad (7)$$

$$Y = \beta_0 x_0 + ln\beta_i x_i + e_i$$

$$\ln Y = \beta_0 x_0 + ln\beta_i x_i + e_i$$

where:

$$Y = \text{dependent variable}$$

$$\beta_0 x_0 = \text{intercep}$$

$$\beta_i x_i = \text{independent variables ranging from i} = 1 \ldots \ldots \ldots \ldots n.$$

$$e_i = \text{error term}$$

However, the best fit model or the lead model of the four fitted functional forms is the semi-log linear function. The coefficients of the semi-log function are usually interpreted in percentage changes, and not variations in levels, with focus on the signs and magnitude of the coefficient for each of the variables of interest. According to

Davidson (1993), the coefficients measure approximately the expected percentage change in the dependent variable (Y) for every unit change in the independent variables ($\beta_i x_i$), all things being equal. Explicitly, the semi-log linear function is expressed as:

$$\ln Y = \beta_0 x_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + e_i \ldots (8)$$

where:

X_1 = gender

X_2 =marital status

X_3 = age

X_4 = years of schooling

X_5 = farm size

X_6 = organization membership

X_7 = access to credit

X_8 = years of experience

X_9 = household size

3. Results and Discussion

3.1. Descriptive analysis

The findings in Table 1 revealed the socio-economic characteristics of the sampled farmers, and the result pointed to the prevalence of female farmers in maize production in the study area, which is also an indication of a better gender representation of maize production in Osun state. From the result presented in Table 2, the respondents' average age is 45 years. This aligns with findings of the research conducted by Ansah *et al*. (2014), Oladeebo and Oluwaranti (2012), Wongnaa, Awuyo-Vitor, and Mensah (2019), that the ageing farming population posed a negative effect on farm profitability. The respondents have an average household size of five persons. This is expected to cushion the labour cost as well as the availability of workforce needed for productivity (Oladeebo and Oluwaranti, 2012; Wongnaa, Awuyo-Vitor, and Mensah 2019). The education status of the farmers, as shown in Table 1 indicates that only 7 (7.4) percent of the sample size are not educated. The result corroborates the findings of other studies (Hyuha *et al.*, 2007; Ansah *et al.*, 2014) that many maize farmers, especially in the rural areas are educated.

Table 1. Socio-economic characteristics of maize farmers

Variable	Frequency	Mean	Std. Dev.
Gender of the farmers			
Male	50 (41.3)		
Female	70 (58.7)		
Age group		44.94	9.2

≤ 30	10 (8.3)		
30 – 35	11 (9.1)		
36 – 40	17 (14.0)		
41 – 45	26 (21.5)		
46 – 50	29 (24.0)		
51 – 55	12 (9.9)		
56 – 60	7 (5.8)		
> 60	8 (7.4)		
Marital status			
Single	41 (33.9)		
Married	50 (41.3)		
Divorced/separated	22 (18.2)		
Widowed	7 (6.6)		
Years of education		9.25	4.4
No formal education	9 (7.4)		
Primary education	29 (24.0)		
Secondary education	46 (38.0)		
Tertiary education	21 (17.4)		
Adult education	15 (13.2)		
Household size		5.4	2.1
≤ 5	73 (61.2)		
6-10	45 (37.2)		
>10	2 (1.7)		
Membership of organization			
Professional	6 (5.0)		
Socio-cultural	15 (7.5)		
Cooperative	10 (8.3)		
Political	73 (60.8)		
Religious	16 (13.3)		
Farm size		0.71	0.32
<1 ha	9 (7.5)		
1-2 ha	46 (38.3)		
3-4 ha	55 (45.8)		
> 4 ha	10 (8.3)		
Access to Credit			
No	90 (75.0)		

Yes	30 (25.0)		
Years of experience		13.2	3.9
≥ 5	19 (15.8)		
6 – 10	43 (36.0)		
11- 15	24 (20.0)		
16 – 20	9 (7.4)		
>20	25 (20.8)		
Total	120 (100.0)		

Source: Field survey, 2021

From the study (Table 1), the mean year of farming experience stands at 13 years. This is a signal that majority of the farmers in the study area have seemingly, adequate knowledge about farming. According to Wongnaa, Awuyo-Vitor, and Mensah (2019), high years of farming experience should have a positive effect on profitability. Also, majority (41 percent) of the farmers are married. Married individuals are expected to combine resources towards the sustenance of the household. The marital status of the respondents justified the dominance of females in maize production in the study as many of them engage in maize farming as a way of supporting the household and to increase their level of incomes. According to Sahu, Agarwala, and Maity (2021), the purpose of agricultural finance is to assist the smallholders enhance their farm production in order to alleviate poverty and famine. However, only a few (25 percent) of the farmers have access to credit for maize production in the study area and majority of them are members of political associations (membership of organization, Table 1). Perhaps, the farmers inability to access agricultural credit could be as a result of their low involvement in cooperative society. This could hinder the farmer's production capacity *vis-à-vis* their profitability in tandem with the findings of Wongnaa, Awuyo-Vitor, and Mensah (2019). In terms of farm size, the area of land utilized by the respondents for production have an average value of 0.7ha, which is consistent with what is obtainable in most developing part of the world (Samberg, Gerber, Ramankutty, Herrero, and West, 2016; FAO, 2015).

3.2. Profitability analysis

The revenue, costs (fixed and variable), return on investments, and farm feasibility per hectare of maize farmers in the study area were presented in Table 2. The indicator of profit was estimated using the income. From the study, the average total revenue estimated from the average output price was above ₦800,000. The findings further revealed that the average variable cost incurred was slightly above ₦77,000, with the bulk on fertilizer procurements. This aligns with the findings of Howard *et al* (2003), Mafongoya *et al* (2006), Vanlauwe *et al*., (2014), and Holen, (2018) that, there is an increased use of inorganic fertilizers in sub-Saharan Africa (SSA) to enable a great increase of crop yields. As such, this might influence the profitability of the farmers in the study area.

Table 2. Cost and Returns of Maize Productions in the Study area

	Input/output (₦)	Unit price (₦)	TR/Cost (₦)
Maize yield (Kg/ha)	3000	270	810,000
Variable cost			
Fertilizer(kg/ha)	6bags of 50kg	6500	39,000
Cost of fertilizer application	50kg	50	300
Plough	Twice	3000	6000
Cost of seedlings(kg/ha)	25kg/ha	200	5000
Cost of harvesting (unshelled)			1500
Cost of Herbicides(L/ha)	5	1800	9000
Cost of Pesticides(L/ha)	5	2000	10000
Application of herbicides per ha			1150
Application of Pesticides per ha			1150
Transportation Cost			1500
Processing cost			3570
Total variable cost			78,170
Fixed Cost			
Land Rent/ha/annum			1500
Total Fixed Cost			1500
Total Cost (TVC + TFC)	78,170 + 1500 = 79,670		
Income (TR- TC)	810,000 – 79,670 = 730,330		
Farm Feasibility ($\frac{TR}{TC}$)	$\left(\frac{810,000}{79,670}\right) = \mathbf{10.167}$Obs		

Source: Field survey, 2021

The R/C coefficient ratio which is the result of a comparison between the acceptance of maize farming and the costs incurred was used as an indicator for the feasibility of maize farming profitability. It also helps to know if the business is viable to be developed. Thus, based on the results of the financial analysis carried out on maize production in the study area, the R/C ratio of maize farming is 10 (10.167), indicating that maize farming is profitable in Osun State, Nigeria.

3.3. Factors influencing profitability of maize farmers in the study area

The regression estimates presented in Table 3 indicated 4 out of the 9 fitted variables had significant relationships with the farmers' income at different confidence interval. From the result in Table 3, age is observed to be positively related to the income of

maize farmers in the study area and is significant at 1%. This implies that the higher the age of the maize farmer in the study area, the more profit. This finding aligns with the work of Otekhile and Verter (2017) on the effect of socioeconomic characteristics of rural farmers in Ojo and Badagry local governments over their peasant income. Although, this result is in contrasts with the arguments of Ibekwe *et al*., (2010) that "the older the farmers the weaker they become".

The influence of marital status on maize farmers' income in the study area is positive and significant at 1% probability level. As discussed earlier, majority of the farmers are married, and given the culture and social values in the study area, spouses are expected to provide labour support on the farm, as well as other investible resources for potential farm expansion. All things equal, and in tandem with Mabe *et al.,* (2010), this revelation is expected to drive increase in the level of farm income streams.

Also, years of schooling had a positive and 1% significant influence on farmers' income in the study area. Meaning, educated farmers possess a higher income possibility than uneducated ones because education improves knowledge. Enhanced productivity as well as the adoption of the latest technologies on inputs that can help farm income can be easily accessed by educated farmers. This result is in line with the works of Sodiq and Singh, (2015); Ogunniyi, (2011); Assa, Edriss, and Matchaya, (2012); Wongnaa, Awuyo-Vitor, and Mensah (2019).

The coefficient of farm size is positive and significant at 1% in the fitted model. This indicates that farmers with more hectares of farmland will have a higher income compared to maize farmers with smaller farm sizes because of the opportunity to produce more maize due to large farmland. Esiobu *et al.,* (2014), Onibuogu *et al.*, (2014), and Adeyemo (2009) established that farmers with large farm size experienced improved technical, allocative, and are efficient with resources.

Table 3. Factors influencing profitability of maize farmers in the study area.

Variable	Coefficient	Standard Error	P>t
Gender	-0.0741134	0.0602904	0.222
Age	0.0139201	0 .0050439	0.007*
Marital status	0.0734032	0.0347151	0.037**
Years of Schooling	0.0387937	0.0073183	0.000*
Household size	0 .0063534	0.0150234	0.673
Membership of Organization	-0.0025636	0.0311999	0.935
Farm size	0.1849396	0.0406650	0.000*
Years of experience	0.0048485	0.004593	0.294
Access to credit	0.0300863	0.081068	0.711
Constant	4.464242	0.1810828	0.000

Source: Data analysis, 2021

4. Conclusion

- Better gender representation, as there are more female maize farmers than male in the study area.
- Reasonable large household size to provide family labour, as well as sufficient farming experience which can be useful to expand the profitability frontier.
- There isa little or no access to credit facilities by the farmers in the study area.
- Despite the fact that the farming operation was profitable, the variable cost incurred appears to be high, and this fell heavily on the cost of inputs.
- Age, marital status, years spent in school, and farm size were found to significantly drive maize farmer's income in the study area.

Recommendations

- Agricultural policies and programs aimed at improving farmer's access to credit in the study area should be encouraged.
- Strategies on farm expansion should be embraced since farm size was found to be positively related to the farmers' income. This may include free tractor service for the farmers to clear their lands, leasing of land to farmers without stringent collaterals.
- Government should design policy on subsidizing agricultural inputs.

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Conflict of interest

Authors declare no conflict of interest.

References

[1] Abdulaleem, M.A., Oluwatusin F.M., & Kolawole, A.O., (2017). Analysis of Costs and Returns on Maize Production among Small-scale Farmers in Osun State Nigeria. *Adult Education*, *26*, pp.14-4.

[2] Adenegan, K.O., Adepoju, A. & Nwauwa, L.O.E., (2012). Determinants of market participation of maize farmers in rural Osun State of Nigeria. *International Journal of Agricultural Economics and Rural Development*, *5*(1), pp.28-29.

[3] Ansah, I.G.K., Oduro, H. & Osae, A.L. (2014). A comparative analysis of profit efficiency in maize and cowpea production in the EjuraSekyedumase District of the Ashanti region, Ghana, Res. Appl. Econ. 6 (4) 106.

[4] Assa, M.M., Edriss, A.K., & Matchaya, G.C. (2012). Unexploited profit among smallholder farmers' in central Malawi: what are the sources? Int. J. Appl. Econ. 9 (2) 83–95.

[5] CIMMYT & IITA (2010). Maize-Global alliance for improving food security and the livelihoods of the resource-poor in the developing world. Draft proposal submitted by CIMMYT and IITA to the CGIARComortium Board. El Batan, Mexico, 91pp.

[6] Davidson, R. & MacKinnon, J.G., (1993). Estimation and inference in econometrics. Oxford University Press *Catalogue*.

[7] FAO, (2015). The economic lives of smallholder farmers: An analysis based on household data from nine countries. *Food and Agriculture Organization of the United Nations*. Rome, Italy

[8] FAO, (2020). *Food and Agriculture Organization of the United Nations*. Rome, Italy: FAOSTAT database. Accessed July 12, 2022. http://www.fao.org/faostat/en/#home.
[9] Gebre, G.G., Mawia, H., Makumbi, D., & Rahut, D.B. (2021). The impact of adopting stress tolerant maize on maize yield, maize income, and food security in Tanzania. *Food and Energy Security*, *10*(4), e313.
[10] Gneiting, U. & Sonenshine, J., (2018). A living income for small-scale farmers: Tackling unequal risks and market power. Oxfam Discussion Paper, UK.
[11] Holden, S.T. (2018). Fertilizer and sustainable intensification in Sub-Saharan Africa global food security.18:20-6
[12] Howard, J, Crawford, E., Kelly, V., Demeke, M, & Jeje, J.J. (2003). Promoting high-input maize technologies in Africa: the sasakawa global 2000 experience in Ethiopia and Mozambique. Food Policy. 28(4):335-48
[13] Hyuha, T.S., Bashaasha, B., Nkonya, E., & Kraybill, D. (2007). Analysis of profit inefficiency in rice production in Eastern and Northern Uganda, Afr. Crop Sci. J. 15 (4) 243–253.
[14] Ibekwe, U.C; C.C. Eze; C.S. Onyemauwa; A. Henri-Ukoha; O.C. Korie& I.U. Nwaiwu (2010). Determinant of farm and off-farm income among farm households in South East, Nigeria. Academia Arena, 2(10): 58-61.
[15] Mabe, L.K., Antwi, M.A., & Oladele, O.I. (2010). Factors influencing farm income in livestock producing communities of North-West Province, South Africa. Livestock Research for Rural Development 22 (8).
[16] Mafongoya, P.L., Bationo, A., Kihara, J. &Waswa, B.S. (2006): Appropriate technologies to replenish soil fertility in Southern Africa. Nutrient Cycling in Agroeosytems 2006; 76(2-3):137-51
[17] Mohammed, S., N. Abubakar, J.E. Ochi & U. Haruna. (2014). Assessment of resource use efficiency in irrigated rice production in Dadinkowa, Gombe state, Nigeria. J. Agric. Sci. Tech. B,427-433. 5.
[18] Monsanto (2014). Water Efficient Maize for Africa (WEMA): Improved Maize Varieties to Aid Farmers in Sub-Saharan Africa. National Bureau of Statistics (NBS) 2014.
[19] Murdia, L.K., Wadhwani, R., Wadhawan, N., Bajpai, P. & Shekhawat, S., (2016). Maize utilization in India: An overview. *American Journal of Food and Nutrition*, *4*(6), pp.169-176.
[20] Nikoyan, A. (2020). The Income and Feasibility Analysis of the Corn Farming in Central Buton District. *JIA (JurnalIlmiahAgribisnis): Jurnal Agribisnis dan Ilmu Sosial Ekonomi Pertanian*, *5*(3), pp.104-110.
[21] Ogunniyi, L.T. (2011): Profit efficiency among maize producers in Oyo state, Nigeria, ARPN J. Agric. Biol. Sci. 6 (2011) 11–17.
[22] Oladeebo, J.O., & Oluwaranti, A.S. (2012): Profit efficiency among cassava producers: empirical evidence from Southwestern Nigeria, *J. Agric. Econ. Dev*. 1 (2) (2012) 46–52.
[23] Olaniyan, A.B. (2015). Maize: Panacea for hunger in Nigeria. *African Journal of Plant Science*, *9*(3), pp.155-174.
[24] Onuwa, G. (2022): Fostering sustainable productivity through maize technology intensification participant responses. Handbook of research on green technologies for sustainable mamngemnet of agricultural resources. Accessed July 12, 2022. www.igi-global.com. Accessed 27/08/22.13:57
[25] Otekhile, C.A., & Verter, N. (2017): The socioeconomic characteristics of rural farmers and their net incomes in Ojo and Badagry local governments areas of Lagos state, Nigeria. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 65(6): 2037-2043.*
[26] Sadiq, M.S., & Singh, I.P. (2015). Application of stochastic frontier function in measuring profit efficiency of small-scale maize farmers in Niger state, Nigeria, J. Agric. Econ. Ext. Rural Dev. 3 (1) (2015) 229–239.

[27] Safa, M.S. (2005): Socio economic factors affecting the income of small-scale agroforestry farms in hill country area of Yemen: a comparison of OLS and WLS determinants. *Small-Scale forestry*, 49(1): 117-134.
[28] Sahu, T.N., Agarwala, V. & Maity, S., (2021). Effectiveness of microcredit in employment generation and livelihood transformation of tribal women entrepreneurs: evidence from PMMY. *Journal of Small Business & Entrepreneurship*, pp.1-22.
[29] Samberg, L.H., Gerber, J.S., Ramankutty, N., Herrero, M. & West, P.C., (2016). Subnational distribution of average farm size and smallholder contributions to global food production. *Environmental Research Letters*, *11*(12), p.124010.
[30] Santpoort, R., (2020). The drivers of maize area expansion in sub-Saharan Africa. How policies to boost maize production overlook the interests of smallholder farmers. *Land*, *9*(3), p.68.
[31] Seffrin, R., Araújo, E.C.D. & Bazzi, C.L., (2018). Regression models for prediction of corn yield in the state of Paraná (Brazil) from 2012 to 2014. *Acta Scientiarum. Agronomy*, *40*.
[32] Sharma, V., Rudnick, D.R. & Irmak, S., (2013). Development and evaluation of ordinary least squares regression models for predicting irrigated and rainfed maize and soybean yields. *Transactions of the ASABE*, *56*(4), pp.1361-1378.
[33] Takahashi, K., Muraoka, R., & Otsuka, K. (2020). Technology adoption, impact, and extension in developing countries' agriculture: A review of the recent literature. *Agricultural Economics*, *51*(1), 31-45.
[34] Ukagwu, J.I., Onuoha, G.U.C., & Iheke, (2014). Profitability of aqua-cultural practice; a case study of fish farmers in Ikeduru local governments area of Imo state. *International Journal of Research in Applied, Natural and Social Sciences*, 2(7): 151-160.
[35] Vanlauwe, B., Wendt, J., Giller, K.E., Corbeels, M., Gerard, B., & Nolte, C.A. (2014). A fourth principle is required to define conversation agriculture in sub-Saharan Africa: the appropriate use of fertilizer to enhance crop productivity. *Field crops research*, 155: 10-3
[36] Wik, M., Pingali, P & Brocai, S. (2008). Global agricultural performance, past trends and future prospects. openknowledge.worldbank.org. accessed 27/08/2022. 13:30
[37] Wongnaa, C.A., Awunyo-Vitor, D., Mensah, A. & Adams, F. (2019). Profit efficiency among maize farmers and implications for poverty alleviation and food security in Ghana. *Scientific African*, *6*, p.e00206.Open access: http://doi.org/10.1016/j.sciaf.2019.e00206.