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Productivity Growth and Food Security Among Maize-Based Farming Households in Nigeria

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Abstract

This study examined the effects of productivity growth on food security among maize-based farming households in Nigeria. Secondary data from Nigeria's General Household Survey Panel was extracted for 572 maize-based farming household heads from the 2015/16 and 2018/19 waves. Data analysis involved use of descriptive statistics, total factor productivity growth calculations, the Markov probability transition matrix, Foster-Greer-Thorbecke (FGT) food security measures and binary logit regression modelling. The average age of maize-based farmers was 50 years, the mean household consisted of 9 people and the average farm size was 1.4 hectares. Productivity growth between both periods was 0.9 percent. Most farmers (73.1 percent) transitioned from low productivity to no productivity between 2015/16 and 2018/19. Most households (59.3 percent) were food secure in 2015/16, while 52.1 percent of the households were food insecure in 2018/19. Productivity growth positively influenced the likelihood of being food secure, alongside household size, secondary and tertiary education levels and non-access to credit. More conclusively, productivity growth improved food security among maize-based farming households in Nigeria. Food security programs should therefore emphasize long-term productivity improvements and the attainment of secondary and tertiary education, rather than mere basic education, in addition to targeting young farmers and improving the production environment of rural areas to enhance productivity growth.

Keywords: Farming households, Food security, Maize-based, Productivity growth, Transition.

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1. Introduction

Maize (*Zea mays L.*) is the second most cultivated crop in the world. Over 170 nations produce 1.48 billion metric tons of maize on a global harvested area of 249.2 million hectares, with an average yield of 5.1 tons/ha (FAOSTAT 2023). The United States of America, China, China mainland and Brazil are the highest producers globally, with annual production of 383.9, 272.8, 272.6 and 88.5 million metric tons respectively, and yields of 11.1, 6.3, 6.3 and 4.7 tons/ha, respectively (FAOSTAT 2023). Maize is the most widely consumed cereal staple in Africa. About 977.6 million metric tons are cultivated annually on 42.5 million hectares with an average yield of 2 tons/ha across the continent (FAOSTAT 2023). The wide gap between average global yields and Africa's yields shows that low maize productivity prevails across the continent. Nigeria's national yield of 1.6 tons/ha trails further away from the global average, pointing to poor maize productivity even though it is the country's most important cereal (Raheem et al. 2021). Maize is the highest source of calories and is preferred over other commonly consumed cereal crops in the country (Okonwu *et al.* 2022). Small-scale farmers are the principal maize producers in Nigeria. Most farmers cultivate maize in combination with other crops and so are not purely maize farmers. They are therefore referred to as maize-based farmers in this study to reflect the production of maize in combination with other crops. They could also be referred to as maize-combo farmers. The savannah vegetation of Nigeria's northern regions is ideal for maize farming and helps to explains why maize is predominantly grown there. The southwestern states of Oyo, Osun, Ondo and Ogun also produce significant amounts of maize. While maize production in Nigeria has increased over the years, the country's average maize yield of 2.1 tons/ha ranks 117th in the world, indicating that little progress has been made in increasing the country's maize productivity. Further, production declined by 1.6 percent between 2019 and 2020, while yields declined by 2 percent in the same period (NAERLS 2020). Maize yields have remained low over the past few decades (FAOSTAT 2023), with negative implications for the country's food security position.

The Food and Agriculture Organization (FAO) defines food security as the ready availability of nutritious and culturally accepted food for everyone at every time in the right amount, quality, and diversity (FAO 2004). At the household level, food security is defined by the United States Department of Agriculture (USDA) as existing when all household members have sufficient food all the time for an energetic, and hearty life (USDA 2008). Ironically, farming households especially, smallholder farmers who comprise the bulk of food producers in Nigeria, also make up the majority of food insecure people (Otekunrin et al. 2021). Up to 57.7 percent of Nigerian households are food insecure pointing to its widespread prevalence (World Bank 2019). Rural communities in particular experience long-term food shortages, leading to malnutrition, unpredictable patterns of food accessibility, poor food quality and costly food, which exacerbates food insecurity and distress among rural populations (Adeoye et al. 2022). Furthermore, hunger and malnutrition have become the leading cause of illnesses, with rising under-five mortality and infection susceptibility (IFPRI 2016). High rates of food insecurity are a key public policy problem in Nigeria. Food demand has outstripped total supply due to the country's substantial population increase, coupled with low agricultural productivity (Posthumus et al. 2018). The national daily caloric intake of 1,730 kcal is substantially below the FAO's recommended minimum daily calorie level of 2,260 kcal (Metu et al. 2016). Furthermore, the population of undernourished people in Nigeria has grown from 12.4 million in 2010 to an estimated 29.4 million in 2020 (FAO 2020), with an even worse situation observed in the country's conflict-prone Northeast region. Nigeria ranks 103rd out of 116 nations and scores 28.3 percent with respect to quality, ability to pay for and access food (Global Food Security Index 2021).

Maize and its products constitute a possible means of combating food insecurity in Nigeria. Ongoing crop developments have reduced the probability of crop failure and may enhance household livelihoods, incomes, and food security on a long-term basis (Masuka et al. 2017). However, maize production in Nigeria is characterized by low productivity. Several local and national programs and policies initiated by the government have targeted improved agricultural productivity. These include: the Agricultural Transformation Agenda (ATA) initiated in 2011, and its successor the Agricultural Promotion Policy (APP) introduced in 2015. Others initiatives include: the National Economic Empowerment and Development Strategy (NEEDS), National Poverty Eradication Program (NAPEP),

National Accelerated Food Production Project (NAFPP), Operation Feed the Nation (OFN) and the Agricultural Development Program (ADP). However, Sallawu et al. (2021) and Aboaba et al. (2020) noted that the programs have had little success, attributing the unsatisfactory results largely to the poor targeting of interventions. Furthermore, government efforts have mostly been short-term, with successive governments not focusing on long-term productivity. Productivity means output per unit input while productivity growth is the sustained increase of productivity over time. Productivity growth is the actual determinant of a society's living standards. For the maize industry, productivity growth allows the sector to compete with other sectors for resources.

Comprehensive empirical knowledge of maize productivity growth and its effects on food security is necessary to properly direct government policies toward addressing Nigeria's low maize productivity and food security issues, especially among farmers. Most studies have dwelt on the determinants of productivity among farmers rather than determinants of productivity growth, which are not abundant in the literature. Existing studies on productivity mostly used ordinary least squares (OLS) regression models (Ibitola et al. 2019; Ukoha et al. 2010). They found that farmers' productivity improved with increases in years of farming experience, labor, land, capital, age, farming experience and household size. Conversely, age squared (life cycle of farmers), years of schooling and sum of days reported sick, had a negative relationship with farm productivity. The effects of farm size on productivity have not been conclusively detailed in the literature. These studies did not capture productivity over time nor did they link it to farmer food security. One study by Mumba (2019), however, focused on productivity growth as the change in Total Factor Productivity (TFP) for maize smallholders in Southern Zambia. The study modeled determinants of TFP change using Pooled Ordinary Least Squares (POLS). The findings showed that plot size, credit access, and cattle ownership were directly related to changes in TFP, while age, family size and drought stress had an indirect relationship with change in TFP.

Further, the link between productivity growth and food security is limited in the literature. A lot of existing literature on food security studies and its determinants among farming households used probit and logit regression models (Ogunniyi et al. 2021; Olufemi and Oladele 2021; Ojoko et al. 2021; Opaluwa et al. 2018; Sekhampu 2013). The results show that farmer experience, sex, household size, total household income, output, distance to the nearest town and family labor have a direct and significant relationship with food security. Conversely, an indirect relationship was found between household food security and off-farming activities and hired labor. The influence of the head of household's age, marital status, education level and farm size on household food security have not been conclusively confirmed. Literature linking productivity growth to food security is limited, despite the importance of productivity improvements over time to attainment of food security and development of agriculture in Nigeria. As the country with Africa's highest population, Nigeria is a key player in the continent's quest for achievement of the Sustainable Development Goals (SDGs). This study therefore asks the following questions: What is the level of productivity and productivity growth among maize-based farmers in Nigeria? What proportion of maize-based farmers transitioned from being unproductive to productive over time in Nigeria? What are the determinants of productivity growth among maize-based farmers in Nigeria? What is the level of food security among maize-based farming households in Nigeria? What is the effect of productivity growth on food security among maize-based farming households in Nigeria? This study's main objective is to investigate the effects of productivity growth on food security among maize-based farmers in Nigeria. This will contribute to the design of appropriate public policies that address the issues of poor productivity growth and food insecurity, especially among maize-based farmers.

2. Materials and methods

Nigeria has a population of 211.4 million people (UN Population Fund 2021) making it Africa's most populous country. It has a land area of 923,768 square kilometres, and varied agro-ecological zones ranging from humid forests in the south to parched savannahs in the north. The south and north have three geopolitical zones each. Southern geopolitical zones include the South East, South West and South-South zones, while the northern zones are North Central, North East, and North West. About 56.7 percent of the country's population is primarily engaged in agriculture (World Bank 2022). Cereals, root and tuber crops dominate food crop production in Nigeria.

This study uses secondary data from Nigeria's General Household Survey (GHS) for the 2015/2016 (Wave 3) and 2018/2019 (Wave 4) periods. A sample of 572 maize-based farming households was extracted that produced complete information in both waves. Data were analyzed using descriptive statistics, Total Factor Productivity (TFP) growth calculations, Markov chain modelling, food security measures of Foster-Greer and Thorbecke (FGT) and logit regression modelling. The measure of how much output can be produced from a given set of inputs is indicated by TFP which represents the productivity of Nigeria's maize-based farmers. TFP is expressed as:

$$\text{TFP} = \frac{P_{it}Q_{it}}{\sum P_{it}X_{it}} \qquad \text{Eq. (1)}$$

where: TFP = The *ith* maize farmer's total factor productivity at time *t*; $P_{it}Q_{it}$ =Total revenue of the *ith* maize farmer at time *t*; $\sum P_{it}X_{it}$= Summed cost in Nigerian Naira (₦) of inputs used (X_i) by the *ith* farmer at time *t*. include Naira (₦) costs of: X_1= maize seed, X_2= labor (per man-day), X_3 = pesticides, X_4 = herbicides and X_5 = tractor hiring, X_6 = ridger hiring, following Ibitola *et al.* (2019). The total factor productivity growth (*TFPG*) was then calculated using TFP in 2015/16 as the base year (TFP_{it-1}), while TFP in 2018/19 was represented as TFP_{it}. Hence, productivity growth was expressed as:

$$\text{TFPG} = \left[\frac{\text{TFP}_{it} - \text{TFP}_{it-1}}{\text{TFP}_{it-1}}\right] \text{x } 100 \qquad \text{Eq. (2)}$$

In this study, TFPG ≤0 indicates negative or no growth; TFPG between 0.01-1.00 indicates low growth, while TFPG greater than 1.00 indicates high productivity growth.

The percentage of maize farmers with no, low or high productivity between the 2015/16 and 2018/19 time periods was achieved using the Markov chain model. TFP_1 and TFP_2 were used as TFP in 2015/16 ($TFPI_{t-1}$) and 2018/19 (*TFPI*), respectively and shown on a probability transition matrix table, P_{ij}. Following Olaleye *et al.* (2009), the percentage of maize-based farming households grouped under each category in the 2015/16 and 2018/19 periods is given by:

$$P(k) = P(0)P_{ij}^{k} \qquad \text{Eq. (3)}$$

where: *P* (0) is the starting probability vector of farmers in 2018/19 for productivity movement (no, low and high productivity); represents the transition probability matrix of maize-based farmers from *i* to *j* (a given productivity group to another); *k* is the time period after which is *P* (1).

Similar to previous studies (Jerumeh *et al.* 2019; Oluwafemi *et al.*, 2019), long-run equilibrium is attained when there is equality in the number of farmers forming a particular productivity group and the number of farmers exiting another given productivity group. It is expressed as:

$$eP = e$$

$$(e_1, e_2, e_3)\begin{bmatrix} P_{11} & P_{12} & P_{13} \\ P_{21} & P_{22} & P_{23} \\ P_{31} & P_{32} & P_{33} \end{bmatrix} = (e_1, e_2, e_3) \qquad \text{Eq. (4)}$$

where: e= (e_1, e_2, e_3) is the vector of steady-state for a three-state Markovian model and e_1, e_2, e_3 denote the long-term prognosis for no productivity, low productivity and high productivity, respectively.

The food security status of the maize-combo farmers' households was assessed using the FGT food security measures. The food security line was two-thirds of the mean per capita household food expenditure (MPCHFE). Food secure households had an MPCHFE equal to or higher than the food security line, while food insecure households were below the food security line. Following Foster-Greer and Thorbecke (1986), Sani and Kemaw (2019), and Ogunniyi *et al.* (2020), the FGT measure is given as:

$$\theta_\alpha = \frac{1}{N}\left(\frac{z - y_i}{z}\right)^\alpha 1(y_i \leq z) \qquad \text{Eq. (5)}$$

where: N = the sum of all sampled households; z = food security line; q = sum of households below the food security line and y_i = monthly household food budget per capita; 1 $(y_i \leq z)$= households with MPCHFE greater than or equal to the food security line; α takes values 0,1,2. The food insecurity headcount (θ_0) denotes the proportion of food insecure households with MPCHFE below the food security line. Food insecurity depth (θ_2) is the proportion of expenditure necessary for food insecure households to climb above the food security line. The severity of food insecurity (θ_2) indicates the additional food expenditure required for a severely food insecure household to move out of severe food insecurity.

Finally, the effect of productivity growth on food security was assessed using the binary logistic regression model. Following Ngema *et al.* (2018) and Agbola (2014), the implicit model is specified as:

$$Z_i = \beta_0 + \Sigma(\beta X_{ki}) \qquad \text{Eq. (6)}$$

where: X_i are parameters that influence the food security status of the household; Z_i is the dependent variable which is dichotomous and denotes the chances of a household being food secure or not (that is, 1 = food secure, 0 = otherwise); β_0 denotes the intercept; β_i are the coefficients of the explanatory variables, X_i to X_{ki} $(see\ Table)$ 1; and u_i denotes the error term.

Table 1: Variable description, measurement and expectation

Independent Variables	Measurement	Prior expectation
Productivity growth	1 if TFGP > 0, 0 if TFPG ≤ 0	+
Sex	male = 1, female = 0	+/-
Age squared	Years	+/-
Marital Status	married = 1, otherwise = 0	+
Household size	Number of people	+/-
Farm size	Hectares (ha)	+/-
Primary education	Attained primary education = 1, otherwise = 0	+
Secondary education	Attained secondary education = 1, otherwise = 0	+
Tertiary education	Attained tertiary education = 1, otherwise = 0	+
Access to credit	Accessed credit = 1, otherwise = 0	+
Sector	Living in urban area = 1, otherwise = 0	+/-

3. Results

The socio-economic characteristics of participating maize-based farmers are described in Table 2. The most recent wave of 2018/19 was used to describe the farmers' characteristics. Most household heads (89.96 percent) were male with an average age of about 50 years and they were mostly married (85.49 percent). The average household size was about 9 people, and most farmers (87.94 percent) had at least some primary education, while 12.06 percent did not have any formal education. Further, 52.15 percent cultivated less than one hectare of land, while the average farm size was 1.4 hectares. In addition, most (88.64 percent) of the maize-based farmers did not access formal credit, and most (76.22 percent) were not members of any cooperative group.

Table 2: Socioeconomic characteristics of maize-based farmers

Variable	Frequency (n=572)	Percentage (%)	Mean	Standard Deviation
Sex				
Male	514	89.86		
Female	58	10.14		
Age (years)				
18-20	5	0.87		
21-30	13	2.27	50.41 years	12.454
31-40	108	18.88		
41-50	186	32.52		
51-60	146	25.52		
>60	114	19.93		
Marital Status				
Married	489	85.49		
Unmarried	83	14.51		
Household Size (number of people)				
1-5	109	19.06		
6-10	311	54.37	9.01 people	4.048
11-15	94	16.43		
>15	58	10.14		
Educational Level				
No formal education	69	12.06		
Primary Education	238	41.61		
Secondary Education	175	30.59		
Tertiary Education	90	15.73		
Farm Size (ha)				
<1	304	53.15		
1-5	243	42.48	1.41 hectares	1.467
>5	25	4.37		
Access to Credit				

Variable	Frequency (n=572)	Percentage (%)	Mean	Standard Deviation
Yes	65	11.36		
No	507	88.64		
Membership of Cooperative				
Yes	136	23.78		
No	436	76.22		

Source: Authors' computations from GHS-P 2018/2019.

Table 3 shows the results for productivity growth among maize-based farmers in Nigeria**.** Most (58.59 percent) farmers experienced no productivity growth between 2015/16 and 2018/19, while 15.04 percent of the farmers had low growth and about a quarter of the farmers had high productivity growth. Mean TFP growth between the two periods was 0.87 percent.

Table 3: Total factor productivity (TFP) growth between 2015/16 and 2018/19 among maize-based farmers in Nigeria

Productivity growth	Frequency	Percentage	Mean	Standard deviation
Negative and No growth (≤0.00)	334	58.39	0.8659	1.681818
Low growth (>0.00 – ≤1.00)	86	15.04		
High growth (>1.00)	152	26.57		
Total	572	100.0		

Source: Authors' computations from GHS-P 2018/2019.

Table 4 shows the probability transition matrix for the productivity of Nigeria's maize-based farmers. About 67.77 percent of the farmers recorded no productivity in 2015/16 and remained unproductive in 2018/19. On the other hand, 15.83 percent of the farmers who had no productivity in 2015/6, transitioned to low productivity in 2018/19, while 16.39 percent of farmers transitioned to high productivity in 2018/19 from no productivity in 2015/16. Further, 73.79 percent of the farmers who had low productivity in 2015/16 transitioned to no productivity in 2018/19, while 10.67 percent of farmers who had low productivity in 2015/16 transitioned to high productivity in 2018/19. Finally, half of the farmers who had high productivity in 2015/16 transitioned to no productivity in 2018/19, while the other half remained in high productivity in the same period.

Table 4: Markov probability transition matrix for total factor productivity

		2018/19			
		No productivity	Low productivity	High productivity	Total
2015/16	No productivity	244 (0.6777)	57 (0.1583)	59 (0.1639)	360 (0.6294)
	Low productivity	152 (0.7379)	32 (0.1553)	22 (0.1068)	206 (0.3601)
	High productivity	3 (0.5000)	0 (0.0000)	3 (0.5000)	6 (0.0105)
	Total	399 (0.6976)	89 (0.1556)	84 (0.1469)	572

Source: Authors' computations from GHS-P 2015/16 and 2018/2019.

The FGT estimates of food insecurity levels for maize-based farming households in Nigeria in 2015/16 and 2018/19 are presented on Table 5. The food insecurity incidence (θ_0) was 0.4266 in 2015/16 and 0.5209 in 2018/19, indicating an increase from 42.66 percent to 52.09 percent in the proportion of food insecure, maize-based farming households in Nigeria. Moreover, in 2015/16, majority of the households were food secure, while in 2018/19, most were food insecure. Further, the depth (θ_2) of food insecurity among the households in 2015/16 and 2018/19 was 15.46 percent and 22.54 percent, respectively. This implies that an average food insecure household needed to increase food expenditure by 22.55 percent in order to move out of food insecurity in 2018/19 compared to only 15.46 percent in 2015/16. Finally, severe food insecurity among farming households was 0.08 percent in 2015/16 and 13.43 percent in 2018/19.

Table 5: Food insecurity indices of maize-based farming households

	Food insecurity incidence	Food insecurity depth	Food insecurity severity	Food insecurity line (two-thirds of MPCHFE) ₦	Mean per capita household food expenditure (MPCHFE) ₦
2015/16	0.4266	0.1546	0.0772	3843.01	5764.52
2018/ 19	0.520979	0.22547	0.134381	3669.96	5504.94

Source: Authors' computations from GHS-P 2018/2019.

The logit regression estimates for the effects of productivity growth on food security among Nigeria's maize-based farming households are shown in Table 6. The model summary shows the Chi-square value of 80.71 percent and adjusted R-squared (R^2) value of 24.52, with the Chi-square statistics significant at 1 percent. This suggests that the food security status of the farmers is sufficiently explained by the independent variables. The variables that were found to influence food security include: productivity growth, marital status, household size, secondary and tertiary education levels, access to credit, and living in the South West, South-South, South East, North West and North East zones. Productivity growth squared had a direct relationship with the likelihood of being food secure, with statistical significance at 1 percent level. This means that as productivity growth increases over time, it is more probable that maize-based households will be food secure by 0.01 percent. Likewise, being married increased the probability of food security, with statistical significance at 10 percent level. This means that the chances of being food secure increases by 32.5 percent when the household head is married, in comparison to being unmarried. Moreover, household size was positively related to food security, with statistical significance at 1 percent level, implying that the chances of being food secure increased by 2.38 percent when the size of a maize-based farming household increased. The secondary and tertiary education levels of the household head were also positively related to food security, with statistical significance at 10 percent and 1 percent levels, respectively. The chances of being food secure increased with possession of secondary education and tertiary education. Conversely, access to credit had an inverse relationship to food security, with a significance level of 10 percent. This means that not having access to credit reduced the chances of being food secure by 18.15 percent for a maize-based household.

Table 6: Logit regression estimates for the effects of productivity growth on food security

Variable	Coefficient	Std. Error	Z	P>|z|	dy/dx
Productivity growth squared	0.0007*	0.0004	1.91	0.057	0.0001
Sex	0.4736	1.2961	0.37	0.715	0.0829
Age squared	-0.0001	0.0002	-0.40	0.689	-0.0004
Marital status	1.8572*	1.0133	1.83	0.067	0.3250
Household size	0.1358***	0.0468	2.90	0.004	0.0238
Farm size (ha)	-0.0978	0.1099	-0.89	0.374	-0.0171
Primary educational level	-0.2729	0.5187	-0.53	0.599	-0.0455
Secondary educational level	0.9786*	0.5119	1.91	0.056	0.1763
Tertiary educational level	2.4287***	0.6618	3.67	0.000	0.4086
Access to credit	-1.0368*	0.6202	-1.67	0.095	-0.1815
Sector	0.8681	0.6687	1.30	0.194	0.1453
Constant	-5.4885	1.3962	-3.93	0.000	
Number of obs. = 238					
LR chi^2 (16) = 80.71					
Prob > Chi^2 = 0.0000					
Pseudo R^2 = 0.2452					

Source: Authors' computations from GHS-P 2018/2019.

Note: ***, **, * indicate significance at 1 percent, 5 percent and 10 percent respectively

4. Discussion

The male dominance in maize farming may be attributed to the rigor of farming operations as this type of farming still mostly uses traditional methods. This finding is in agreement with Fadare et al. (2014), who found that the majority of maize farmers in Nigeria are male. The age of the farmers indicated that most were in their productive years, although, youth participation was relatively low. This is consistent with the findings of Kehinde and Tijani (2021). The observation on household size showed that maize farming households in Nigeria are fairly large. This could have positive implications for the maize-based farmers who use family labor in their farm operations and is similar to the findings of Zongoma et al. (2015). Furthermore, most farmers (87.94 percent) had at least primary-level education, while 12.06 percent did not have any formal education. Most household heads were somewhat formally educated and could adopt agricultural innovations to aid productivity and enhance food security status, in line with Girei et al. (2018). Furthermore, small-scale farmers dominate maize production in Nigeria as Saleh et al. (2018) confirmed. Additionally, the lack of access to formal credit meant that finance was sourced from personal savings or other informal sources. The high cost of borrowing, need for collateral, and lack of knowledge about available credit facilities may account for this. Gershon et al. (2020) agree that most farmers in Nigeria have no access to credit. Similarly, most maize farmers are not members of any cooperative group, implying that only a few farmers enjoy the benefits of membership such as access to credit and high-quality production inputs provided by cooperatives. This is in alignment with research by Onuk et al. (2010) and Ajah and Nmadu (2012).

The low productivity growth observed among the farmers indicates low maize productivity over time in Nigeria. Adedeji et al. (2017) also found positive growth in crop productivity over a 54-year period for Nigeria. Positive yet low growth may not be sufficient to achieve the desired levels of development for the sector. This has implications for the effectiveness of policies on agricultural productivity in Nigeria.

The productivity transitions indicate that only a modest improvement in maize productivity occurred between 2015/16 and 2018/19, while most farmers remained unproductive. This further indicates that most maize farmers experienced worsening productivity levels relative to those who experienced improvements. This is in agreement with the FAO (2022) which reported that Nigeria's agricultural productivity has been stifled due to several agricultural policy and development issues such as land tenure, low levels of irrigation, climate change and land degradation.

Rising food insecurity among maize-based farming households in Nigeria is not expected since farmers are food producers, and so should be food sufficient and food secure. Productivity growth over time is expected to be directly related to food security as it increases farm incomes and ultimately improves food security. Likewise, a married household head is responsible for satisfying their family's food demands, in comparison to an unmarried one. Although, household size and food security may not be directly related, a large household could translate to more family labor available to produce more food which could ultimately improve food security as the study by Maitra and Rao (2015) confirms. With respect to education, the positive relationship between secondary and tertiary education levels of the household head is plausible since education enhances the skills and productive capabilities of the farmers. This finding is consistent with Irohibe and Agwu's (2014) research. Credit constraints faced by many smallholders may be responsible for the inverse relationship found between access to credit and food security, which was contrary to our expectations. Only a fraction of the loan required or applied is usually released to farmers, resulting in the incapacity to benefit as expected from the credit obtained. This is in agreement with Agidew and Singh (2018), who concluded that credit access does not influence the food security status of rural households.

5. Conclusion

This study investigated the effects of productivity growth on the food security of maize-based farmers in Nigeria between the 2015/16 and 2018/19 periods. The data analysis established that on average, maize-based farmers had low productivity growth between both periods. Most maize-based farmers either remained unproductive in both periods or transitioned from being productive in 2015/16 to being unproductive in 2018/19. The factors that impeded the farmers' productivity growth were age, membership of cooperatives and rural residence, while increasing farm size and being male improved productivity growth. Moreover, the levels of food security among maize-based farming households worsened between 2015/16 and 2018/19. The study determined that productivity growth improves food security among Nigeria's maize-based farming households, alongside increasing household size, attainment of secondary and tertiary educational levels, and non-access to credit. Food security interventions by the government should therefore include a long-term plan to improve productivity growth among Nigerian farmers. Moreover, education interventions for farmers should go beyond the basic level, which is the current focus of Nigeria's government. Policy should focus on education up to secondary and tertiary levels, as attainment of these higher levels improves food security among maize-based farming households. Finally, the government should increase investments in rural areas to improve the production environment for farmers since the study found that living in rural areas reduced productivity growth among farmers.

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