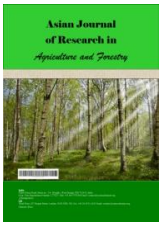

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Cassava Productivity Growth in Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author ZOO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BTO and AOA managed the analyses of the study. Author FAS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Cassava has gained prominence in the world and has become economic crop in the Nigerian agricultural sector. Secondary data was used for this study. The required variables were extracted from General Household Survey Panel Data (GHS-P). The GHS-P is a nationally representative survey of households across Nigeria covering urban and rural sectors. Analytical tools used included Total factor productivity and Markov chain. 82% of populations of Cassava farmers are in the rural areas and close to 73% were young adults including both male and female involved in cassava production. Approximately 65% of the cassava based farmers were single that not yet married and most of the farmers were educated and about 80% and 98% of the cassava based farmers did not have access to credit facilities and extension personnel respectively. Generally, the cassava productivity growth was erratic and very small proportion of cassava farmers that were in lower productivity reduced overtime, while the minimal proportion of cassava farmers that moved into both moderate and high productivity increased overtime respectively. Generally, there is more to be done to increase and attain sustainable high level cassava productivity growth in Nigeria.

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1. BACKGROUND OF THE STUDY

Cassava (*Manihot esculenta)* is a key economic crop in the world and very important in the Nigerian agricultural sector. In Nigeria, there has been a production projection of continuous upward in total cassava output, [1]. Increasing in cassava output has made Nigeria the world's largest producer of Cassava [1,2]. However, the current cassava yield per hectare in Nigeria is very low; is between 7.72 and 12.3 tons per hectare. Nigerian yield is about 66% lesser than India that has the highest yield [3,4]. This implies that increased cassava output in Nigeria is not as a result of improved productivity but expansion of hectares of arable land. In other words, cassava productivity is currently not optimized. Generally, available studies and data have further confirmed low cassava productivity specifically in Nigeria [4,5,6].

The concept of productivity is essential and important measurement of growth [7,8]. It is a relative concept with comparisons being made either across time or between different production [9]. Its measurement could be partial or total (multifactor). Total factor productivity measures aggregate output per aggregate inputs used in production, while partial productivity measures output per single input used.

However, the questions that easily come to mind are: Is the productivity of every cassava farmer low? Has there not been increase in cassava productivity status of some of the farmers' over time? What are the patterns of changes in cassava productivity among the farmers now and in the future? What is the future prospect of cassava productivity among Nigerian farmers? There is urgent need to tackle these questions and provide empirical answers that will inform relevant policy necessary to boost cassava farmers' productivity status in Nigeria. Therefore this research is vita now for most of available literature and submissions made on cassava productivity none address afore-mentioned issues raised and forecast the future of cassava productivity growth [10,11].

Methodologically, the review of research works on cassava productivity in Nigeria has revealed that many of researchers have not explored the application of Markov chain principle to their findings in agriculture [12]. The submissions made by the majority of these previous researchers were basically reports of means and probably standard deviation. This generalization could be misleading in formulation and recommendation of appropriate policy. Therefore, further research analysis could be done by breaking total factor productivity into levels according to [13,14,15]. Then the future pattern of productivity changes among the farmers could still be explored using Markov chain principle.

Therefore, categorization of productivity into levels would provide basis to adjudge the current performance; whether productivity of a given cassava farmer improves or not over time. Therefore, Markov chain analysis was used to analyze cassava productivity and more importantly, it was also used to forecast the proportion of cassava farmers that are likely to be in a given cassava productivity category in the future.

1.1 Study Area

The study area of this research work is Nigeria. The spatial distribution of the population is uneven, with the majority (63 percent) of the population living in rural areas and the remaining population living in urban areas. With a wide range of climatic, vegetation and soil conditions, Nigeria possesses the potential for wide range of agricultural production.

The population of Nigeria was estimated to be 201,793,302 people as of 16 May 2019 [16]. The vegetation profile is divided based on the agro-ecological zones; the dry savannah, the humid forest and moist savannah. The fourth agro-ecological zone, the mid-altitude is mainly a small part of the North Central Nigeria [31].

Crop production in Nigeria is dominated by cereal, root and tuber crops. The most commonly grown root crop is cassava, which is grown in almost all the States in Nigeria [17].

1.2 Type and Source of Data

Secondary data was used for this study. The required variables were extracted from General Household Survey Panel Data (GHS-P) from the Living Standard Measurement Survey-Integrated Survey of Agriculture (LSMS-ISA) of 2010-2011, 2012-2013 and 2014-2015. The ability to follow the same households over time makes the GHS-

Panel important for studying and understanding the dynamic of productivity over time.

The GHS-P is a nationally representative survey of households across Nigeria covering urban and rural sectors. For this study, relevant information and variables relating to cassava farmers was extracted and used for the analysis. Information such as cassava farmer households' socio-economics characteristics and cassava input and output data were sorted and analyzed using STATA command. Lastly, cassava farmers with complete data set were used in the actual analysis to achieve the set objectives of this study.

1.3 Analytical Tools

$$TFPI_{it} = \frac{\sum P_{qit} Q_{it}}{\sum P_{xit} X_{it}} \quad (1)$$

Where:

$TFPI_{it}$ = Total factor productivity index of farmer i at time t

$\sum P_{qit} Q_{it}$ = Total revenue of cassava farmer i at time t

$\sum P_{xit} X_{it}$ = Summation of cost of inputs used by cassava farmer i at time t

X_{it} = vector of independent variables at time t, X_i include

X_1 = Cost of cassava stem (₦per bundle)

X_2 = Labour cost (₦ per man -day)

X_3 = Cost of pesticides (₦ per litre)

X_4 = Cost of insecticides (₦ per liter)

X_5 = Cost of herbicides (₦ per litre)

1.4 Categorization of Total Factor Productivity Index (TFPI)

In order to classify the cassava-based performance into categories; low, moderate and high level, on the basis of farmers' total factor productivity indices, the upper limit of mean (mean plus standard deviation) value of total factor productivity index was divided into three points following [13] thus:

Given, upper limit of mean of farmers' total factor productivity index is φ, then if:

TFPI< $\frac{\varphi}{3}$ the total factor productivity of the farmer is categorized as low productivity.

TFPI≥ $\frac{\varphi}{3}$ and <$\frac{2\varphi}{3}$, the total factor productivity of the farmer is categorized as moderate productivity.

TFPI ≥ $\frac{2\varphi}{3}$, the total factor productivity of the farmer is categorized as high productivity.

To predict the proportion of cassava farmers that will be in lower, moderate and high productivity overt time.

The outcome of total factor productivity index of the cassava farmers' in the previous ($TFPI_{t-1}$) and current ($TFPI_t$) year was used to construct probability transition matrix table.

P_{ij} is the probability of transiting from state i to j [18].

$$P(k) = P(0)\, P_{ij}^{k} \quad (2)$$

Where;

P (0) represents the vector of initial probability of farmers in period 2 for low, moderate and high productivity movement.

P_{ij} represents the probability transition matrix.
K stands for period after period 2 which is P (1).

At equilibrium the number of farmers entering a particular productivity category is expected to be equal to the number of farmers moving out from a particular productivity category.

Equilibrium is reached in Markov chain model when:

$$eP = e \quad (3)$$

Where:

e = (e_1 e_2 e_3) is the steady state vector for a three- state Markovian model [19]:

e_1 represents the long term projection for low productivity,
e_2 represents the long term projection for moderate productivity,
e_3 represents the long term projection for high productivity,
P_{ij} represents the probability transition matrix

$$(e_1, \quad e_2, \quad e_3) \begin{pmatrix} P_{11} & P_{12} & P_{13} \\ P_{21} & P_{22} & P_{23} \\ P_{31} & P_{32} & P_{33} \end{pmatrix} = (e_1 \quad e_2 \quad e_3) \quad (4)$$

2. RESULTS AND DISCUSSION

2.1 Summary of Cassava-Based Farmers' Population in the GHS-Panel Survey

The summary of cassava based farmers captured in the General Household Survey panel (GHS-P) of the year 2010-2011, 2012-2013 and 2014-2015 waves respectively are presented thus. After data extraction of relevant variables, 2010-2011 wave has total of two thousand, three hundred and twenty-two cassava based farmers with one thousand five hundred and forty-four cassava farmers who had not yet harvested while seven hundred and seventy-eight had harvested. The total population of cassava based farmers in the 2012-2013 wave was two thousand, one hundred and twenty-eight, out of which one thousand five hundred twenty-seven had not harvested while six hundred and one had harvested their cassava tuber. 2014-2015 wave has total population of one thousand nine hundred and sixty-two cassava based farmers, with one thousand two hundred and seven had not yet harvested while seven hundred and fifty-five had harvested their crop.

For this study, only cassava based farmers who had harvested were used. However, in order to have balanced panel data and information of the same set of farmers across the three waves, six hundred and one of cassava based farmers that had complete data across the three waves were used in the final analysis.

Table 1 presents the outcome of the sectorial analysis of cassava-based farmers and it shows that 82% of populations of Cassava farmers are in the rural areas and the remaining 18% reside in urban areas in Nigeria. This result affirms that many of cassava based farmers are in rural areas. It had been said that food production is a major occupation of the rural populace and Nigeria remains an agrarian country [20,21,22]. The gender analysis shows about 52% of the farmers are male while close to 48% are female. The closeness of the proportion of male and female population implies there is apparently no strict dichotomy of gender specific on production of cassava and both gender are responsible for producing cassava. The reason for this could be according to curb food crisis. Ndukwu [23] and FAO [24] stated that women participated in all aspects of farm work often to an extent as men. Durno and Stuart [25], noted that women produce the bulk of basic food stuffs both for household consumption and for sale.

Table 1. Socioeconomics characteristic of cassava-based farmers, Nigeria

Variable		Frequency	Percentage
Sector	Urban	108	18
	Rural	493	82
Gender	Male	286	47.6
	Female	315	52.4
Age (years)	< 20	40	6.7
	20 – 39	437	72.7
	40 – 59	77	12.8
	≥60	47	7.8
Marital Status	Single	390	64.8
	Married	172	28.6
	Divorced	4	0.6
	Widow(er)	36	5.9
Education	Non-Formal	151	25.1
	Primary	184	30.6
	Secondary	197	32.7
	Tertiary	70	11.6
Access to credit	Access to credit	119	20
	No Access to credit	482	80
Extension visit	Extension visit	13	2
	No Extension visit	588	98
Stem Cutting	Improved Stem	286	48
	No Improved Stem	315	52
	Total	601	100.0

The analysis of age of the respondents for this study was carried out following the [26], age groupings. Larger proportion; close to 73% of the cassava based farmers were young adults; followed by middle age adults (12.8%) while the remaining were adolescents (6.7%) and older persons (7.8%). The mean age was about 30 years with standard deviation of 20 years.

The distribution of the age groups show that most of the farmers were at their active ages and this implies majority have attributes desirable of a typical farmer- relatively young, energetic and can engage in active economic activities. The relative young age groups have been characterized with ability to bear risk, flexibility to new ideas and innovative with high tendency to do manual work as it required on the farm, [23 and 27]. According to Ibrahim et al. [28] farmer's age has great influence on their productivity. If the inherent potential and characteristics of these cassava farmers could be harnessed, it will contribute tremendously to the national growth of cassava productivity in Nigeria.

The result of analysis of marital status of cassava-based farmers shows that approximately 65% of the cassava based farmers were single that not yet married and close to 29% of the respondents were married while nearly 6% and 1% of the farmers under this study were widows(ers) and divorced respectively. The higher proportion of singles that correlate with young age groups in this study suggests and presumes that cassava farming is drifting from subsistence systems to commercialized farming system for the following reasons. Firstly, cassava farming is now more of market oriented. This is due to the fact that youths that are still single will offer larger proportion of their cassava for sale than just family consumption. Moreover, cassava farming had been engaged as source self-employment by some young graduates as substitute for white-collar job. The single take cassava farming as business that could earn them tangible income. The larger proportions of youths and singles engaging in cassava farming could be connected with Agricultural transformation Agenda (ATA) policy of federal government in past eight (8) years that encouraged youth participation in farming activities. Okeowo et al. [29] stated that youths are major groups needed for agricultural transformation in Nigeria.

The role of education as channel of information required for optimum performance in a given sector cannot be over-emphasized. Therefore, the educational statuses of cassava –based farmers were analyzed and the result is shown on average, majority of these farmers had formal education with close to 31% and 33% had primary education and secondary education respectively. While nearly 12% had post-secondary educational qualifications and one-quarter (25%) of the respondents did not have formal education. Generally, three-quarters, 75% of the cassava-based farmers under this study were educated, implying that there is potential for increased cassava productivity since education will enable farmers to have access to improved knowledge and information on new agricultural innovation(s) that will enhance their productivity. Notably, formal education is a catalyst for the adoption of modern production technologies and effective communication system that encourage increase in the productivity of any agricultural venture [30,32].

The role of timely credit accessibility is very crucial for smooth running of any production unit for optimum performance, particularly agricultural production that is time bound. Therefore, the credit accessibility of cassava-based farmers was examined and the result shows that the level of credit accessibility was poor; about 80% of the cassava based farmers did not have access to credit facilities while 20% have enjoyed financial aids from credit providers. There might be diverse reasons for low level of access to credit facilities among the farmers and it could be lack of necessary information, subsistence and low scale of production, inadequate collateral security, distance and procedures of the credit and many more.

Extension service bridges the gap between the research findings of scientists and information needs of farmers. According to the results of this analysis, the cassava based farmers did not enjoy the benefits of extension visit either from government extension officers or non-governmental extension service providers. Nearly all the farmers, 98% responded that there was no extension officer visit to their farm. This implies these farmers lack latest ideas and knowledge on cassava production techniques that could boost their productivity level. Lack of extension personnel to visit could cause scanty of necessary technical information and perpetual low productivity. This could also be responsible for low level of cultivation of improved varieties of cassava stem cuttings as indicated.

The agronomists have developed many improved varieties of cassava stem cuttings that give better yield. The cultivation of these improved varieties by the farmers was critically considered. The outcome of analysis revealed that about 50% of cassava base farmers were not still cultivating the improved varieties of cassava stem cuttings. This has negative effects on the general performance and specially cassava productivity among the farmers. There could be various factors responsible for failure for cultivation of improved varieties, among such could be lack of information or awareness of new varieties, lack or inadequate extension officers, cultural and traditional beliefs, non-availability of improved cassava varieties stem cuttings, and many more.

Table 2 presents the results of productivity transition of cassava farmers' status over time. The results generally reveal that productivity growth status of some cassava farmers was dynamic. The overview of the results show that proportion of cassava farmers that were in lower productivity reduced overtime, while the proportion of cassava farmers that were in both moderate and high productivity increased overtime respectively. The reduction in the population of cassava farmers in the lower productivity category and increase in the number of cassava farmers moving into moderate and higher level of productivity categories signify overall marginal improvement in cassava productivity over time.

According to the analysis of cassava productivity transition that occurred between wave1 (2010-2011) and wave2 (2012-2013) using P_o as base period, about 0.25% probability of farmers that were in lower productivity status have tendency of moving out and 0.08% entered moderate and 0.17% moved into higher productivity in the first year (P_1) respectively. At the end of second year harvesting period (P_2), there were close to 0.21% probability of cassava farmers transiting from lower productivity status into moderate (0.04%) and high (0.17%) productivity respectively. The third harvesting seasons (P_3) also indicated about 0.68% probability would escape low productivity trap and 0.27% moved into moderate productivity level while the remaining 0.41% of cassava farmers entered high level of productivity. The fourth harvesting period shown that close to 0.57% of cassava farmers would exist low productivity status and 0.20% and 0.37% will enter moderate and high productivity status respectively.

The outcome of examination of cassava productivity transition that occurred between wave2 (2012-2013) and wave3 (2014 – 2015) using P_o as base period, approximately 1.93% probability of population of farmers on lower productivity level would had improvement and out of which 1.21% of the farmers' entered moderate and 0.72% had higher productivity respectively in the following planting season (P_1) . Whereas, in the second planting season (P_2), 1.02% probability of the farmers exited lower level of productivity to enter moderate (0.26%) and higher (0.76%) productivity levels respectively. At the end of third chain of cassava production, out of 0.95% probability that had improvement in their productivity scale, not less than 0.22% increased their performance to moderate level and about 0.73% made higher cassava productivity level. The result of Markov chain for the fourth production period indicated that about 0.98% probability escaped lower cassava productivity syndrome to enter moderate (0.21%) and higher (0.77%) levels of cassava productivity groups respectively.

Finally, the cumulative effects of the three years of cassava production lines of activities (Wave1, wave2 and Wave3) was considered and this shows overall levels of cassava farmers'

Table 2. Forecast of productivity transition status of cassava farmers, Nigeria

Year		Wave1 to wave2			Wave2 to Wave3			Wave1 to Wave3		
Category		**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
P_o	%	85.50	8.20	6.30	73.88	6.99	19.13	73.88	6.99	19.13
P_1	%	85.25	8.28	6.47	71.95	8.20	19.85	72.94	7.20	19.86
	Δ%	- 0.25	0.08	0.17	- 1.93	1.21	0.72	- 0.94	0.21	0.73
P_2	%	85.29	8.24	6.47	72.86	7.25	19.89	71.94	8.24	19.82
	Δ%	- 0.21	0.04	0.17	- 1.02	0.26	0.76	- 1.94	1.25	0.69
P_3	%	84.82	8.47	6.71	72.93	7.21	19.86	71.97	8.22	19.81
	Δ%	- 0.68	0.27	0.41	- 0.95	0.22	0.73	-1.91	1.23	0.68
P_4	%	84.93	8.40	6.67	72.90	7.20	19.90	71.97	8.23	19.80
	Δ%	- 0.57	0.20	0.37	- 0.98	0.21	0.77	- 1.91	1.24	0.67

productivity improvement status from 2010 to 2015 production seasons, that is wave1 to wave3.

The overview of the outcome of the cassava productivity transition that occurred between wave1 (2010-2011) and wave3 (2012-2013) show overall marginal reduction in the population of cassava farmers on lower productivity scale and a relatively steady increase in the proportion of cassava farmers that had attained either moderate or higher productivity levels.

The transition that occurred between wave1 (2010-2011) and wave3 (2014-2015) using P_o as base period and P_1 as period one (first planting year) revealed that 0.94% probability of the cassava farmers had better performance. This implies there was reduction in the proportion of cassava famers with lower productivity status and increase in the population of farmers that transited into moderate (0.21%) and high (0.73%) of cassava productivity respectively. The second period of Markov analysis result indicated that about 1.94% probability cassava farmers moved out of lower productivity level and 1.25% entered moderate productivity level, while the remaining 0.69% joined cassava farmers with high productivity profile. The third and fourth of Markov chain results among the cassava producers in this study shown that 1.91% probability opted out of low cassava productivity threshold. This caused about 1.23% and 0.68% increase in probability or proportion of cassava farmers with moderate and high productivity respectively.

The relative improvement in the cassava productivity among producers in Nigeria within the period under consideration could be accounted for as a result of agricultural policy of the Federal government. It should be recalled that the periods (2010-2015) under consideration was exactly the time when Federal Government of Nigeria introduced Agricultural Transformation Agenda and cassava initiative was one of the targeted crop of the programme. However, based on the empirical results derived from this study, majority, at least 70%, of cassava farmers are still trapped within low cassava productivity threshold. This is an indication that there is more to be done to increase and attain sustainable high level cassava productivity in Nigeria.

3. SUMMARY AND CONCLUSION

Larger population of Cassava farmers are in the rural areas and the age group shown that young adults including both male and female are involved in cassava production. Approximately majority of the cassava based farmers were single that never married and most of the farmers were educated and 80% and 98% of the cassava based farmers did not have access to credit facilities and extension personnel respectively. Generally, the cassava productivity growth was erratic and very small proportion of cassava farmers that were in lower productivity reduced overtime, while the minimal proportion of cassava farmers that were in both moderate and high productivity increased overtime respectively. In conclusion, there is more to be done to increase and attain sustainable high level cassava productivity growth in Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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