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Empirical Analysis of the Determinants of Cocoa Productivity in Cocoa-producing Areas of Nigeria

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Abstract

This study was conducted in Nigeria to empirically evaluate the determinants of the Cocoa productivity in three zones that are cocoa–producing areas of Nigeria (Southwest, South/South-East and North-Central). Geo-referenced primary data were collected from cocoa farmers in ten (10) cocoa-producing states from the selected zones using Open Data Kit (ODK Collect) and focus group discussion. Collected data were analyzed using descriptive and inferential statistics. The results from the pooled data of states visited revealed the dominance of males (94%) among cocoa farmers, with a mean age at 55.7 ± 13.30 years, year of cocoa farming experience of 38.5 ± 13.51 years, household size of 8 ± 3.00 persons and with only two persons assisting on the cocoa farm as family labour, on average. The mean farm size was 3.68 ± 2.66 ha, and the mean years of the cocoa plantation were 28.48 ±16.08. Cocoa productivity is generally low, with Southwest zones had 503 kg/ha, the South/South-East recorded 375 kg/ha, while North Central had, 148 kg/ha. The regression analysis showed model with good fit and combined influence on all significant variables of cocoa productivity. Household size and farm size ($p<0.001$), land ownership, fertilizer access ($p<0.05$), and use of fungicides are significant at a 10% level of probability. This implies that increasing the area cultivable to cocoa with land ownership without litigation or any form of sanctions, fertilizer access and use of fungicides will increase cocoa productivity in all regions. This study recommends the provision and increased access of cocoa-specific fertilizer to boost productivity in areas where land is unavailable for production to boost cocoa yield in producing states.

Introduction

Cocoa production is important to Nigeria's economy, as it is produced in over 14 states of the 36 states of the country in varying capacities; some are high-producing, medium-producing and low-producing states. Cocoa is still the leading agricultural export of the country, and Nigeria is currently the world's fourth largest producer of cocoa with 328,263MT, after Ivory Coast, Indonesia and Ghana (WPR, 2023) and the third largest exporter, after Ivory Coast and Ghana. Verter and Bečvářová (2014) reported cocoa as the major foreign exchange earner for Nigeria in the 1950s, 1960s and 1970, the country was the second largest producer in the world. Still, owing to investments in the oil sector between 1970s/1980s, Nigeria's share of world output declined. In 2010, cocoa production accounted for only 0.3% of agricultural GDP.

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Agricultural Productivity can be defined in general terms as the ratio of the value of total outputs to the value of total input used in farm production (Olayide and Heady, 1982). Giving a background of the trend, FAO (2015) reported that average cocoa bean production in Nigeria between 2000 and 2010 was 389,272 tonnes per year, rising from 170,000 tonnes produced in 1999. It fell back to 192,000 tonnes in 2015 and 2016; in 2017, the country produced 367,000 tonnes of cocoa and the export data from 2017 revealed that Nigeria exported 161,285.72 MT of agricultural produce, with cocoa accounting for 33,294 MT of this total. Currently, Nigeria is the world's fourth biggest cocoa producer, with a turnout of 284,232 tonnes in 2023 (FAO, 2024). In the third quarter of 2024, Nigeria exported ₦624.71 billion worth of cocoa compared to the ₦171 billion worth of 2023, and in the last quarter of 2024, the exported value of cocoa soared by 606 percent to a whooping ₦1.21 trillion (NBS, 2024).

Currently, the price of cocoa at the local and international market is high. Cocoa beans have high demand in the international market with a good price too. It becomes imperative to increase the productivity of cocoa for the benefit of farmers and to improve the Gross Domestic Product (GDP) in Nigeria. Mahmud (2023) in his study on factors affecting agricultural productivity of crop farmers found that fertilizers, herbicides, labour, late onset of rain and high interest rates are militating against productivity of crop farmers in Nigeria. Coulibaly and Erbao (2019) ascertained the factors that influenced cocoa production in Cote d'Ivoire and identified a longtime relationship between cocoa output, labour, land and fertilizer implements. Also, carbon dioxide emissions and political stability had no statistically significant effect on cocoa production. Cocoa production in Cote d'Ivoire is not affected by non-economic factors. The study concluded that stakeholders can work on the identified factors to improve cocoa production in Cote d'Ivoire.

Manrique *et al.,* 2023 estimated the determinants of an area harvested in cocoa production systems using secondary data from the National Agricultural census, correlational method, cross section and quantitative approaches were used. The study revealed that major areas lack credit, advice and irrigation but used organic fertilization. The areas affected by violence had less harvested areas. The study concluded that the determinants of harvested area showed a low management behaviour in the agronomic practices of cocoa producers. Continuous training and education of the producers were essential to improve the problematic situation.

Although the optimization of cocoa productivity depends on many factors, among which adequate agronomic practices and favourable weather conditions are notable but studies have found that an increasing return to scale in variable inputs use among the farmers can increase production output and socio-economic factors such as age, education levels, secondary occupation, sex and marital status of the farmers influences cocoa farmer inefficiency (Lawal *et al.*, 2015). Interestingly, cocoa still remains the leading agricultural export of the country (NBS, 2024). Hence, this study which assessed the determinants of productivity of cocoa in the country based on production regions is pertinent, so that factors that improve productivity can be harnessed for sustainable livelihood of farmers and foreign exchange earnings for the nation.

Objectives:

1. To describe the socio-economic characteristics of the cocoa farmers in Nigeria;
2. To identify the determinants of cocoa productivity in the cocoa-producing areas of Nigeria;
3. To empirically analyze the determinants of cocoa productivity in Nigeria.

Materials and Methods

Study area

Primary data were collected from the cocoa-producing zones; Southwest (SW) states: Ondo, Oyo, Osun, Ogun and Ekiti; South-South/South-East (SS/SE): Cross River, Abia, Akwa-Ibom and Edo; North-Central (NC) - Kogi State in Nigeria using Open Data Kit (ODK Collect).

Data collection: The zones were geo-referenced and data were collected on socio-economic and farm-related characteristics of the farmers Analysis of Descriptive analysis such as frequencies, percentages, mean and standard deviation of the cocoa farmers and farm characteristics were carried out using the

disaggregated and pooled data of the cocoa-producing zones in Nigeria. The regression analysis was done on the productivity (kg ha^{-1}) of cocoa by dividing the total quantity of dried fermented beans (kg) by the total farm size (ha). Also, stepwise multiple regressions were used to ascertain the parameters that significantly determined productivity of cocoa. These analyses were done on the regional and pooled data of the three cocoa-growing areas in the three zones to reflect the factors specific to each area.

Analytical Techniques

Based on the large number of potential predictor variables, Stepwise regression model was specified each for the analysis per zone where independent variables were selected for the model by iteration, variables were added and removed based on their p-values statistical significance by forward and backward selections in SAS. The general stated formula for the study was:

$$Y= b0 + b1X1 + b2X2 + + b3X3+ b4X4+ b5X5+\ldots\ldots\ldots\ldots..+ bnXn + e$$

Where Y is the dependent variable, and X1-Xn are the independent variable, b1-bn are the regression coefficients and e as the error term.

b1 = Age of farmer (years)
b2 = Farm size (hectares)
b3 = Household size (person)
b4 = Educational Status (years)
b5 = Land ownership (1, if yes; 0 otherwise)
b6 = Fertilizer access (1, if yes; 0, otherwise)
b7 = Use of fungicide (1, if yes; 0, otherwise)
b8 = Membership of association (1, if yes; 0, otherwise)
b9 = Record keeping (1, if yes; 0, otherwise)
b10 = Training on soil fertility (1, if yes; 0, otherwise)
b11 = Family labour (1, if yes; 0, otherwise)
b12 = Cocoa farming experience (Years)

Results and Discussion

The results of the pooled socio-economic data (Table 1) of the ten states visited revealed dominance of males (94%) among cocoa farmers, with a mean age of 55.7 ± 13.3 years, indicating that cocoa farmers are ageing and thus the need to encourage active participation of women and the youths. The mean year of cocoa farming experience is 38.5 ± 13.51 years. The mean household size is 8 ± 3.00 persons and with only two persons assisting on the cocoa farm as family labour, on average. The mean farm size was 3.68 ± 2.66 ha. This implies that most cocoa farms are fragmented smallholdings owned by farmers who still engage in the traditional ways of farming with few or no labour-saving devices. This justifies the need for the intensification of production/ha of available land. The average age of the trees is 28.48 ± 16.08 years implying that farmers are likely to benefit from use of cocoa fertilizer as most of the trees are getting old.

The results from the regions revealed that in all the regions (SW, SS/SE, and NC) cocoa farmers were mostly males, with mean ages as 57.23 ± 13.4; 53.44 ± 12.96 and 60.32 ± 11.67 years respectively which indicates that the cocoa farmers' population is getting old in all regions with no sure replacement for sustainability of production especially in the South-west which is the major hub for cocoa production in the country. These calls for the involvement and encouragement of youths and women into the cocoa production value chain for sustainable production. The years of cocoa farming experience in the regions are 32.05 ± 13.8, 24.18 ± 11.70, and 29.22 ± 14.4 years respectively; these show the farmers are well-grounded in the production of cocoa with the least years of experience as 24 years. Household size was 8, 7 and 6 persons per household respectively in the regions indicating that generally, the households are big with a modal size of 5. This can have a negative effect on welfare and could also be pass mark if such families engage in use of family labour.

Cocoa productivity is generally low (Table 2) in the three cocoa-growing zones. The SW region had the highest average production of 503 kg/ha and 375 kg/ha in SS, while the NC region had 148 kg/ha. The production figures obtained in the regions is in accordance to expectations of productions within the two cocoa cropping seasons with higher production in the main season than the light crop, except for the year 2017 when the light crop recorded was higher than the main crop; this was due to changes in climate for that year (Sayina, 2017).

The outcome of the regression analysis (Table 3) shows that the F value of 8.85 for the model was $p<0.001$ significant at 1 percent level of probability indicating that model has a good fit with the Adjusted R-square of 0.06 and has combined influence on all significant variables of cocoa productivity. This result reveals the determinants of productivity are household size, and farm size ($p<0.001$), land ownership, fertilizer

Table 1: Descriptive Statistics of Socio-economic Variables

Variable	Pooled data (Mean, and Standard Dev.)	SW region	SS region	NC region
No. of States	10	5	4	1
Age of farmer (yrs)	55.7±13.3	57.23±13.4	53.44±12.96	60.32±11.67
Years of cocoa farming experience	38.5±13.5	32.05±13.8	24.18±11.70	29.22±14.4
Household size (persons)	8±3.00	8±3.00	7±3	6±3.00
Farm size (ha)	3.6±2.6	3.83	4.05±0.59	3.32±1.90
Age of cocoa trees (yrs)	28.4±16.0	30.28±15.7	25.92±15.88	32.86±18.78

Source: Field survey, 2021/22

Table 2: Descriptive Statistics of Production Figures in All Regions

Variable	Pooled data (Mean and Standard Dev.)	SW region	SS region	NC region
No. of States	10	5	4	1
Mean production	425.0	503.6	357.8	148.0
Production light 2018(kg)	933.07±176.0	864.6±138.3	1026.9±876.6	885.7±454.2
Production main 2018kg)	2296.92±641.0	2618.2±459.8	1932.4±906.8	1594.3±702.7
Production light 2019(kg)	753.6±22.0	649.5±97.8	825.8±105.1	----------
Production main 2019(kg)	1349.6±550.6	854.4±114.8	1696.3±315.01	----------
Production light 2020(kg)	860.2±153.4	702.5±116.1	985.01±114.7	200.0
Production main 2020(kg)	1634.0±360.0	1199.5±169.31	2256.2±482.7	365.0
Production light 2021(kg)	4160.0	13064.1	970.8	296.0
Production main 2021(kg)	2519.0	6229.4	1566	223.00

Source: Field survey, 2021/22

access ($p<0.05$) and use of fungicides are significant at 10% level of probability for cocoa productivity in all the regions. An increase in household size and farm size will boost cocoa productivity. Fertilizer access by farmers will also boost their productivity. Land ownership and access to fertilizer will increase and boost productivity in all cocoa regions in Nigeria meaning expansion and improved output.

In Table 4, this result implies that the determinants of productivity in the NC zone are farm size and fertilizer access ($p<0.001$), educational status and record keeping ($p<0.05$) while training on soil fertility, age

Table 3: Stepwise Regression of Cocoa Productivity in All Cocoa Regions

Variable	Model R-Square	F-Value	Pr>F
Household size	0.0262	18.59	<0.0001***
Farm size	0.0449	13.51	0.0003***
Land ownership	0.0512	4.54	0.0335**
Fertilizer access	0.0563	3.76	0.0529**
Use of fungicide	0.0605	3.09	0.0791*
Membership of Assoc	0.0639	2.48	0.1159
Model F Value 8.85	(<0.0001)		
R-Square = 0.0605			

Source: Field survey, 2021/22

cocoa farmers, and land ownership at 10% level of probability are significant for cocoa productivity.

Table 4: Stepwise Regression of Cocoa Productivity in NC Zone

Variables	Model R-square	F-value	Pr>F
Fertilizer access	0.2	8.2	<0.0089***
Farm size	0.5	10.6	0.0046***
Educational status	0.7	4.4	0.0482**
Record keeping	0.7	4.6	0.0467**
Land ownership	0.8	4.3	0.0532**
Training soil fertility	0.5	3.3	0.0823*
Age of farmer	0.6	3.8	0.0634*

Source: Field Survey, 2021/22

For the SW region (Table 5), the determinants of cocoa productivity are membership of associations and use of fungicides are significant for cocoa productivity at p<0.001, farm size at p<0.05, while land ownership and household size are significant at (p<0.01). The memberships of association been significant have implication of social capital and learning among farmers in group to share latest production information to boost their crop productivity. For the prevalence of fungi attacks in the region, the use of fungicide will lessen the outbreak to give way for productivity. So also, higher farm size with needed practices will lead to high productivity. The 10% level significance of household size in the area may be due to low level of use of family labour in the area.

Table 5: Stepwise Regression of Cocoa Productivity in SW Nigeria

Variable	Model R-Square	F-Value	Pr>F
Use of fungicides	0.03	9.89	0.0018***
Farm size	0.08	3.94	0.0479**
Membership of association	0.72	4.49	0.0027***
Land ownership	0.06	3.74	0.0539*
Household size	0.07	3.47	0.0632*
Family labor	0.08	2.38	0.1235

Source: Field survey, 2021/22

The results from SS/SE zone (Table 6) revealed that household size and farm size are significant (p<0.001), pruning was also significant (p<0.05), while family labour is significant at (p<0.01) for cocoa productivity in the zone. Indicating that socio-economic and farm management factors affect productivity in the area.

Table 6: Results of Stepwise Regression of Cocoa Productivity in SS/SE/ Nigeria

Variable	Model R-Square	F-Value	Pr>F
Household size	0.0725	23.46	< 0.0001***
Pruning	0.0016	6.28	0.0127**
Farm size	0.0916	6.28	0.0097***
Family labor	0.0083	2.80	0.0952*
Record keeping	0.0064	2.18	0.1410

Source: Field survey, 2021/22

Conclusion

The overall result reveals that socio-economic and farm management factors affect cocoa productivity in Nigeria. Increased farm and household sizes can help to increase cocoa productivity. This implies that increasing the area cultivable to cocoa with land ownership without litigation or any form of sanctions, in addition to fertilizer access and use of fungicides, can increase productivity to desired levels in all growing zones and throughout the country.

Since it is a known fact that farm sizes cultivable to cocoa may not increase, this is a good entry point for the use of cocoa-specific fertilizer to boost production in the producing areas so that the little land available for production can be made to yield at the maximum expected threshold through the application of location-specific cocoa fertilizers for sustainable production, output and income of the farming households and as foreign exchange earnings for the nation.

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