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Profitability and Resource Use Efficiency among Cassava-based Farmers in Ondo State, Nigeria

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Abstract
Cassava is an important crop with great potential to improve agricultural growth owing to its wide range of use including consumption and industrial use. Previous studies have analyzed the resource use efficiency with little or no consideration for scientific procedure of hypothesis testing. Therefore, this study examined the profitability and resource use efficiency of cassava-based farmers in Ondo state. Descriptive statistics, simple budgetary techniques and Cobb Douglas production function were used to analyze the primary data. The results shows that majorities of the respondents were male (75%), smallholder farmers (81.50%) with less than 5ha, with a mean age of 49.4 years. The study also found that cassava production was profitable with a gross margin of ₦48,379.85 per hectare. The partial elasticity of cassava cuttings, labour and farm machinery were positive and significantly influenced the total output. labour and herbicide application were over utilized. The return to scale for cassava production was 1.505 implying increasing return to scale. Hence, the need to improve the capacity building of cassava-based farmers on effective and efficient utilization of herbicides and labour inputs is imperative.
Keywords: Cassava-based, Profitability, Gross Margin, Cobb-Douglas and Resource use

Introduction
Cassava (*Manihot esculenta crantz*), which is grown in many tropical countries of Africa, Asia and Latin America is one of the major staple food crops in Nigeria. It is one of the world's most important food crops (Asogwa *et al*., 2013) with a total output of over 277 million tonnes in 2016 against 71 million metric tonnes in 1961 (Food and Agriculture Organization, 2018). It can be processed into starch, ethanol and high quality cassava flour (HQCF) which can be used in confectioneries such as baking. Cassava roots are very rich in starch and contain significant amount of calcium (50 mg/ 100 g), phosphorus (40 mg/100 g) and vitamins (25 mg/100 g). Surplus production of cassava products enters international trade in different forms such as chips, broken dried roots, meal, and flour and tapioca starch. Dried cassava roots and meal are used as raw materials for compounding animal feeds, while cassava starch is used for industrial purposes; grocery tapioca is used solely for human consumption. (Odoemenem and Otanwa 2011). Cassava products are generally accepted by all classes of Nigerians, which makes it attractive to farmers (Itam *et al.* 2014). The crop and its derivatives have excellent potentials in livestock feed formulation, textile industry, plywood, paper, brewing, chemicals, pharmaceutical and bakery industries (Sanni, *et al.,* 2008) . It is an important source of dietary carbohydrate and provides food for over 60 million people in Nigeria (Adebowale *et al.*, 2008).) . The roots are processed into garri, fufu, tapioca, chips and cassava flour for human consumption (Sanni *et al.,* 2008; Adebowale *et al.,* 2008).

Reports show that Nigeria is the world's largest producer of cassava contributing about 20% of the world's production translating to 47, 406, 770 tonnes, followed by Thailand, Indonesia, Brazil, Ghana and Congo (Oishimaya, 2017). However, when compared to many other countries that are found below Nigeria in global ranking of cassava production, the Nigeria's average yield of 7.7 tonnes per hectare is very low. For instance, the average cassava yield per hectare in Indonesia and Thailand are 23.4 tonnes and 22.2 tonnes respectively (FAO, 2017). Evidence from statistics shows that the annual growth rate of the Nigerian population between 2016 and 2019 averaged 2.63%, while the crop production growth rate during the same period is estimated at an average of 2.53% (World Population Prospect, 2019; Statista, 2022). The implication is that, a great number of people are left with consumption of fewer calorie than they require thus leading to hunger and malnutrition. Olomola (2018) reported that the percentage of undernourished people in Nigeria increased from 5.9% in 2008 to 7% in 2016 suggesting that, attaining Sustainable Development Goals (SDG-1and 2) for no hunger and zero poverty by the year 2030 is doubtful. Furthermore, the 2018' report of Food and Agriculture Organisation of the United Nation shows that Nigeria is one of the most food insecure and poverty stricken countries in the world. This is because the Nigeria agricultural sector including the staple crop cassava production is dominated by a large number of smallholder farmers with each cultivating less than 2ha in scattered plots and employing traditional technology (Elijah, 2014) and

Several programmes and initiative have been instituted in the past towards improving agricultural productivity and efficiency. Notable among them are Root and Tuber Expansion Program (2001), Cassava Seed Multiplication Programme, Input Expansion policy of the government in cassava industry and Presidential Initiative on Cassava Production and Export (2002). Further, IITA implemented the Integrated Cassava Project (ICP) to support the presidential initiative on cassava. These efforts have failed to yield the expected result of improved cassava productivity in Nigeria. This can be attributed to the fact that cassava production over the last half a century are largely driven by land area expansion as opposed to improve cassava productivity through efficient use of resources. In addition, the problem of declining crop productivity in Nigerian agricultural sector which hinges on the efficiency with which farmers use resources on their farms is an important consideration for improving the cassava productivity. In the face of declining farm size due to population pressure, land degradation and loss of soil fertility resulting from agricultural intensification, the possibility of increasing production through the expansion of farm area has increasingly been diminished. Therefore, the outcome of this study is expected to provide useful hints for policy makers on improving the yield per hectare of cassava production through the efficient use of the resources given the existing level of farm size. The relevant questions that this study attempted to answer are (i) what is the level of profitability of cassava farmers in the study area? (ii) What is the output response of the production inputs? (ii). Are the resources efficiently utilized? (iv). what is the return to scale of cassava production in the study area?

Numerous studies (Ibekwe *et al.,* 2012; Ogunniyi *et al.,* 2012; Ogbeherioborue *et al.,* 2016 and Okebiorun *et al.,* 2018) have been conducted on profitability and resource use efficiency in cassava production. However, these studies have failed to take into consideration the duality concept of the production function as the inclusion of socio-economic and demographic variables (such as age, gender, household size, farm experience, education etc.) in the specification of output response production function constitute mis-specification and inconsistent with theory (Rahji, 2019). Further, resource use efficiency was determined in these studies by examining the MVP (marginal value product) and MFC (marginal factor cost) ratio. While this approach satisfies the necessary condition for determining the efficiency of resource use, it does not satisfy the sufficient condition as it does not follow the scientific approach of hypothesis testing and statistical significance of difference in MVP and MFC ratio (Rahji, 2019).

The foregoing suggests a gap in knowledge that this study intended to fill taking into account the duality concept-with the premise that production function is a mirror image of the cost function-in the specification of cobb-Douglas production function. Cobb-Douglas production function was preferred by this study because its coefficients directly represent the output elasticity of inputs and easy for interpretation and estimation than translog frontier (Coelli and Battese, 1998). The use of Cobb-Douglas production function permits testing of hypothesis (e.g. t-test of significance of the difference in MVP and MFC) as well as the calculation of confidence intervals needed to assess the reliability of the estimations (Dharmasiri, 2012).

Methodology

Study Area: This study was carried out in Ondo State of Southwestern Nigeria. It consists of 18 Local Government Areas (LGAs). The total land area is 15,500 km². The state has a total population of about 3.4 million inhabitants (National Population Commission, 2006). The state is bounded in the West by Osun and Ogun States and in the North by Ekiti and Kogi States, in the East by Edo and Delta states and in the South by the Atlantic Ocean. It is situated between latitudes 5º45' and 7º52'N and longitudes 4º20' and 6º5'E. The main cash crops produced in the state are cocoa, oil palm, cashew, while the arable crops include yam, cassava and maize for domestic consumption and exports.

Data Collection and Sampling Procedure: Primary data employed in this study were obtained with the aid of structured questionnaires. A multi-stage sampling technique was employed in the selection of the respondents. The first stage involved purposive selection of Owo ADP out of four ADP Zones in Ondo State due to large concentration of cassava farmers in the zone. The second stage involved purposive selection of four blocks (LGAs) out of six blocks in Owo ADP zone due to high concentration of cassava farmers in the LGAs. The selected blocks are: Akoko North-east, Akoko North-west, Ose and Akoko South-west. The third stage involved random selection of five communities from each of the LGAs making a total of twenty communities selected for the survey. In the fourth stage, 210 cassava farmers were randomly selected proportionate to the size of communities. However, only two hundred copies of questionnaire were used for the analysis. The remaining ten copies were rejected due to incomplete information, loss and inconsistency.

Methods of Data Analysis: The analytical techniques used in this study include descriptive statistics, Budgeting techniques, Cobb-Doulas production function, Resource use efficiency; Elasticity of production (EOP) and Return to scale (RTS). The Descriptive statistics used include frequencies, means, percentages, standard deviation and t-test.

Budgeting Techniques: The budgeting technique involving the Gross Margin (GM) analysis was used to estimate the profitability of cassava among cassava farmers. Gross margin of a firm is the difference between the Total Value of Production (Total Revenue) and the Total Variable Cost (TVC) of production.

-.. (1)

Where subscript i refers to i-th respondents, while j represents j-th variable costs.

TR = Total value of cassava product/ha
GM = Gross margin/ha
TVC = Total Variable Cost/ ha
Pi = Unit price of cassava output from the i-th enterprise in (₦)
Qi = Quantity of harvested cassava produce in tonnes/ha
C j = Unit price of inputs used (₦)
X j = Quantity of variable inputs used in number
$\sum$ = Summation sign

If GM > 0, then the farm enterprise is profitable; If GM < 0, then the farm enterprise is not profitable.

Cobb-Douglas production function: Following the works of Osundare and Owoeye, (2018); Okebiorun *et al.* (2018) and the Cobb-Douglas production function for farm-level cassava production is implicitly specified as follow:

=α .... (2)

The full specification of the physical measure-based Cobb-Douglas production function for cassava farming in the study area is as follow:

= .... (3)

Where is the price (₦) per unit kg of the cassava produce, is the quantity of cassava harvested (kg), = quantity of cassava cuttings (number), = size of farm (ha), = Number of man-days by hired labour = Farm machinery (hrs.), = quantity of herbicide (kg).

Resource Use Efficiency: Following Norman (1972); Alfred-Ochiya and Allison-Oguru, (1990) and the works of Umar and Abdulkadir, (2015); Ali *et al.* (2017) and Rahji and Falusi, (2005) and Rahji, (2019), the ratio of the "values of marginal product (VMP) to the marginal factor cost (MFC) for each of the variable inputs was computed and tested for its significance using t-test

That is, $\frac{MVP}{MFC} = r$.. (4)

Where, r = Efficiency ratio with the condition that r > 0; VMP = Value of Marginal Product and MFC = Marginal Factor Cost. An input is said to be under-utilized if *r* >1, and this implies that the utilization of a given resource is below the optimum level. Increasing the rate of use of that resource will help increase productivity. If *r* < 1, the level of resources use is above the optimum level thus implying over-utilization of a given input. Reducing the rate of use of that resource will improve productivity. A given input is said to be efficiently utilized if *r* = 1. This indicates that a given input is optimally utilized.

In this study, all the inputs specified in the Cobb-Douglas production function were expressed in monetary terms. As a result, the slope co-efficient of these independent variables represent the MVPs. The formular for t-test of significance of the difference in MVP-MFC ratio as proposed by Norman (1972) and as further adopted by Rahji and Falusi (2005) is given as:

= .... (5)

Where = calculated value of t-statistics; is the value of marginal product of input obtained by multiplying the coefficient of each input by the unit price of cassava output. is the total output of cassava (kg) produced by each farmer, is the total quantity of input used in the production, is the variance for the coefficient () of input .

: = = 0 No significant difference between the VMP and MFC of input x

: ≠ = ≠ 0; There is a significant difference between VMP and MFC of input x

Decision criteria: If the null hypothesis of no significant difference between the VMP and MFC is rejected at any of the given levels of significance, then the interpretation of r-value is statistically valid at any instance.

Elasticity of Production and Return to Scale: Elasticity of production measures the degree of responsiveness of cassava output to a unit increase in a given input (partial elasticity of production) or to a unit increase in all the inputs (total elasticity of production). Returns to scale is described as the sum total of partial elasticities for the selected inputs specified in the production function. It is measured as the ratio of percentage increase in output divided by the percentage increase in input under the condition that all factors be increased by the same proportion. For Cobb- Douglas function, the elasticity of each input is given by its corresponding coefficient in the estimated production function. This individual elasticity can be summed to determine the return to scale (Ugwumba, 2011).

The returns to scale (RTS) for this study is expressed as:

= +.....................+

Given that RTS is Return to Scale,,,, and are partial elasticities with respect to cassava cuttings, farm size, labour, machinery, fertilizer and agrochemicals respectively. If βi > 1, it implies increasing returns to scale; If βi < 1, indicates decreasing returns to scale and if βi = 1, it implies constant returns to scale.

Results and Discussion

Socio-economic Characteristics of the Respondents

Table 1 shows the distribution of respondents by socio-economic characteristics. The result of the field data revealed that 75% of the respondents were male, while 25% were female. This implies that there were more male than females among cassava farmers in the study area. In most of the developing countries including Nigeria, the agricultural production system is labour-intensive that often require strenuous activities thus making it difficult for female farmers to engage in full time farming. In terms of age, it was revealed that 32.0% of respondents were at most 40 years of age, 29.0% were between 41 and 50 years, 23% aged between 51 and 60 years, while 16.0% aged above 60 years. The mean age of the respondents was about 50 years. This implies that majority of the cassava farmers were within the productive age and thus able to carry out most farming activities that are often associated with drudgery. This finding is in line with Enimus, (2015). Majority of respondents were married (92.0%), while 4.5% and 3.5% were single and widowed respectively. This implies that married farmers, given the size of their households, tend to have easy access to production inputs including labour and thus able to benefit from reduced cost of production. This findings agrees with Enimu *et al.* (2016).

In terms of household size, 47.5% of respondents had 6-10 members of household, 34.0% had at least 5 members, 15.0% had 11-15 members, while the least percentage of respondents had household size of above 15 members. The mean household size in the study area was 8 members indicating a relatively large household size in the study area. There was high level of literacy among the respondents as 78% of the respondents completed either primary (24.5%), or secondary (45.0%) or tertiary (8.5%) level of education, while less than a quarter (22.0%) had no formal education. This finding is in line with Girei *et al.* (2014) who reported that higher level of education determines the quality of skills acquired by farmers, their allocative capacities and efficiency and also how well-informed they are in terms of innovation and improved technologies. Farming was the primary occupation for majority (90.9%) of the respondents, while 9.05 were primarily engaged in off-farm/non-farm activities. This implies that farming was predominantly the major source of livelihood. Table 1 further shows that majority (66.50%) of the respondents had above 20 years of farming experience, 22.5% had 11-20 years of experience, while 11.0% had at most 10 years of experience.

The high level of farming experience was likely to improve the productive capacity of most respondents in terms of better access to improved seeds, technology as well as market information. This finding agrees with Onbuogu, (2013). More than three-quarter (81.5%) of cassava farmers in the study area were smallholder farmers with farm size of at most 5 acres, while 15.0% and 3.5% had 6-10 and above 10 acres of farm size respectively. This implies that, majority of cassava farmers in the study area might find it difficult to commercialize their farm enterprises as higher share of their outputs or income would be consumed by the household as stated by Engel's law.

Table 1: Distribution of Respondents based on Socio-economic Characteristics

Characteristics	Frequency	Percentage (%)
Gender of the respondents		
Male	150	75.00
Female	50	25.00
Age		
≤40	64	32.00
41-50	58	29.00
51-60	46	23.00
>60	32	16.00
Marital Status		
Married	184	92.00
Single	9	4.5
Widowed	7	3.5
Household Size		
1-5	68	34.00
6-10	95	47.50
11-15	30	15.00
>15	7	3.50
Educational level		
No formal education	44	22.00

Primary	49	24.50
Secondary	90	45.00
Tertiary	17	8.50
Primary Occupation		
Farming	121	90.95
Others	18	9.05
Farming Experience		
1-10	22	11.00
11-20	45	22.50
>20	133	66.50
Farm size		
0-5	163	81.50
6-10	30	15.00
>10	7	3.50

Source: Field Survey, 2019

Determining the Profitability of cassava-based farmers

The budgeting technique was used to analyse Gross Margin of cassava farmers in order to determine the profitability. The result as presented in table 2 shows that average cost of fertilizer, cassava cuttings, transportation, labour, spraying, cutlass, Hoe, Land, planting, Harvesting, Machinery and Herbicide are ₦4812.15, ₦8330.25, ₦47967.05, ₦78280.10, ₦2797.71, ₦4822.91, ₦4997.11, ₦6152.15, ₦5389.15, ₦5686.49, ₦2408.02, ₦6768.54 respectively. The highest cost in cassava production was expended on labour input suggesting that the ability of cassava farmers to commercialize their products might be restricted due to labour intensive system of production which is likely to affect their productivity and income level.

Furthermore, the total variable cost among cassava farmers is ₦173,599.49 and total revenue is ₦221979.34. The gross margin per hectare of ₦48379.85 shows that cassava production in the study area is profitable. This agrees with Otu *et al.* (2016); Angba and Iton (2020) who found that cassava farming is highly profitable and can be used to improve the economic potentials of rural households.

Table 2: Result of the Gross Margin analysis for Profitability of Cassava-based Farmers

Variable	Average Cost	Total cost
Fertilizer	4812.15	962,429.17
Cassava cuttings	8330.25	1,666,050.00
Transportation	47967.05	9,593,410.87
Labour	78280.10	15,656019.04
Knapsack	2797.71	559541.03
Cutlass	4822.91	964,581.36
Hoe	4997.11	999,422.69
Land	6152.15	1,230,430.86
Planting	5389.15	1,077,830.86
Harvesting	5685.49	1,137,297.53
Machinery	2408.02	481,604.24
Herbicide	6768.54	1,353,708.13
TVC	173599.49	34,719,897.52
TR	48,379.85	44,395,867.52
GM=TR-TVC	48,379.85	9,675,970.10

Source: Field Survey, 2019

Determinants of Output Response to inputs in Cassava Production

The result of the deterministic production function for cassava as presented in table 3 revealed that the overall fitness of the model as indicated by F statistics was 102.09 and statistically significant at less than

1% thus indicating a good fit of the model. Also, the coefficient of determination which shows the percentage of total variation in cassava output explained by the independent variables in the model was 0.7246. This implies that about 72% of the total variation in cassava output were explained by the independent variables specified in the model. Further, 3 out of 5 independent variables specified were significant at given levels of significance.

The elasticity of production with respect to cassava stem cutting is positive and significant ($p<0.01$). This shows that a 1% increase in the quantity of cassava cuttings increases the total output of cassava by 36.9%. This implies that, increasing the plant density will increase the plant population, other factors remain constant and therefore increase the cassava yield. This finding agrees with Ojimba (2017) and Buhari *et al.* (2018). The labour elasticity of cassava output is 0.1329 and significant ($p<0.10$). The significant positive relationship between the number of man-days spent on the farm and total output shows that an increase in number of man-days by 1% increases the quantity of output produced by 13.29%. This finding is consistent with Okebiorun, (2018). This implies that increasing the number of man-days on the farm suggests timely and prompt farm operations such as weeding/herbicide application, fertilizer application, and harvesting and thus improved cassava output. This is in line with Ogunniyi *et al.* (2012).

The elasticity of total output with respect to farm machinery is 0.5741 and significant ($p<0.05$).This shows that an increase in working hours of farm tractor machinery by 1% increases the total output by 57.4%. This implies that increasing the number of hours spent in the farm for land clearing and tillage operations tend to loosen the soil particles for easy water and nutrient percolation for improved absorption by the plant nutrient, thereby increasing the total output.

Resource use efficiency among cassava-based farmers

The result of the calculated resource use efficiency as shown in table 4 revealed that the value of marginal product (VMP) for cassava cuttings, farm size, labour, herbicide and machinery are: 27.69, 29.60, 9.97, 2.56 and 43.06 respectively. The ratio of VMP to MFC which measures the efficiency of resource use are 1.44, 0.0074, 0.0083, 0.0016 and 29.51 respectively for cassava cuttings, farm size, labour, herbicide and machinery respectively. However, the t-statistics test as shown in table 4 revealed that only the variable inputs of labour and herbicide are statistically significant.

Table 3: Deterministic Production Function for Cassava

Variables	Coefficients	Standard error	T-ratio
Cassava cuttings (no)	0.3692***	0.1247	2.96
Farm size (acre)	0.3947	0.3443	1.15
Labour (man-days)	0.1329*	0.0873	1.52
Herbicides (kg)	0.0341	0.0497	0.69
Farm machinery (hrs.)	0.5741**	0.3096	1.85
Constant	3.6045	0.8872	4.06
F (5, 194):	102.09		
Prob.>F:	0.0000		
R-squared:	0.7246		
Adjusted-R-Squared:	0.7175		

Source: Field Survey, 2019. *, **, and *** indicate levels of significance at 10%, 5% and 1% levels of significance respectively.

The resource use efficiency of labour (0.0083) and herbicide (0.0016) are less than 1 and statistically significant indicating that less inputs of labour and herbicides must be used to maximize output in cassava production. The labour and herbicide inputs use had exceeded the optimum levels of production and further use of these inputs will add less to the total output. These findings are consistent with Ojimba *et al.* (2017). Therefore, the two significantly production inputs used in cassava production were over-utilized, implying that if they are efficiently utilized, more output and hence, more income could accrue to the resource – poor farmers in the study area.

Table 4: Result of the Resource use Efficiency r computed from VMP and MFC

Variable	MPP ()	VMP () ₦	MFC () ₦	r =	value	Decision rule
Cassava cuttings	0.3692	27.69	19.19	1.44	0.94	Underutilized
Farm size (acre)	0.3947	29.60	400	0.0074	0.06	Over-utilized
Labour (man-days)	0.1329	9.97	1200	0.0083**	9,161.48	Over-utilized
Herbicide (kg)	0.0341	2.56	1600	0.0016**	7.89	Over-utilized
Machinery (hrs.)	0.5741	43.06	1270	29.51	0.43	Underutilized

Source: Author's computation from field survey, 2019. The unit price of cassava output is ₦75.00/kg

Returns to Scale among the cassava Farmers

The calculated "return to scale (RTS)" among cassava-based farmers was shown in table 5. This was obtained by summing all the estimated partial elasticities of Cobb-Douglas production function. The result revealed that the sum of the partial elasticities for all the inputs used was 1.505 implying increasing returns to scale. This indicates that cassava-based farmers in the study area were at the increasing stage of production. This implication is that, any additional increase in total inputs by one unit will add more to total product as the computed elasticity for all the inputs were greater than one. Also, it shows that farmers were operating on stage I of the production function where farmers get increasing return from extra unit of inputs. This agrees with Ojimba (2017); Buhari *et al.* (2018). The theoretical implication is that cassava-based farmers were still in a rational stage of production where marginal physical product is still positive.

Returns to Scale (RTS) in Cassava Production

Inputs	Elasticity(Coefficients)	Stage	Return to Scale
Cassava cuttings	0.369	I	Increasing Return to Scale (IRS)
Farm size	0.3947		
Labour	0.1329		
Herbicide	0.0341		
Farm machinery	0.5741		
Total	**0.505**		

Source: Field Survey, 2019.

Conclusion

The focus of this study was to examine the profitability and resource use efficiency of cassava-based farming in Ondo state, Nigeria. Based on the analysis from the descriptive and inferential statistics, the study found that majority of cassava-based farmers in the study area were small holder (81.50%) with highest farm size of 5ha, male (75%), married (92.0%), educated (78%) and within the age range of active labour force (845). Cassava production was found to be profitable in the study area with a gross margin of ₦48,379.85 per ha. Findings from the study also showed that "labour" and "herbicide" were not optimally utilized as these two critical production inputs were over-utilized. Further, taken all the production inputs with a unit increase, the results showed that cassava-based farmers will have their output increased by more than proportionate increase in the selected inputs evident from "return to scale" coefficient (1.505). Thus, farmers should engage in agribusiness of cassava production as it was found to be profitable. However, cassava-based farmers should adopt less intensive use of labour and herbicide resources in order to increase cassava productivity.

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