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Productivity Analysis of Cassava-Based Production Systems in the Guinea Savannah: Case Study of Kwara State, Nigeria

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Abstract: This study assessed the productivities of prevalent cassava-based farms in the large Guinea Savannah ecology of Nigeria. For the study, 160 cassava producing households were selected across the Kwara State Agricultural Development Project (KWADP) zones and interviewed. The study data were analysed using the Total Factor Productivity (TFP) and the Ordinary Least Squares (OLS) regression methods. The study findings revealed the cassava/maize enterprise with a 4.4 TFP level as the most popular and most productive cassava-based enterprise. This was followed by the Cassava/Cowpea, Cassava/Maize/Guinea-corn and the Cassava/Melon systems with 4.1, 3.6 and 3.5 TFP levels respectively. The study also revealed that land, labour, educational status of the household head and the fertilizer input significantly influence the productivity levels in cassava-based farms. Therefore, to achieve increased crop yield per cost outlay in cassava-based production systems, the study recommends the enhancement of farmers' access to education and the encouragement of the use of land and labour saving technologies in the cassava cropping systems.

Key words: Total factor productivity · Partial productivity indices · Cassava-based production systems · Kwara State · Nigeria

INTRODUCTION

Cassava is a very important crop to Nigeria. Its comparative production advantage over other staples serves to encourage its cultivation even by the resource poor farmers. The crop's production is generally thought to require less labour per unit of output than other major staples. Cassava is able to grow and give reasonable yields in low fertile soils. It is a good staple whose cultivation if encouraged can provide the nationally required food security minimum of 2400 calories per person per day [1].

Recently, production figures ranked Nigeria as the leading producer of cassava in the world. In 2004, the estimated cassava output from Nigeria was approximately 34 million tonnes. This production performance has rated Nigeria as the largest cultivator of cassava in the world [2]. This feat is sequel to the on-going cassava multiplication programme in the country [3]. In 2002, cassava suddenly gained prominence in Nigeria following the pronouncement of a presidential initiative on the crop. The initiative was aimed at using cassava production as the engine of growth in Nigeria. In recent times, government has encouraged the use of the crop to produce a wide range of industrial products such as ethanol, glue, glucose syrup and bread. Recently, the Nigerian government promulgated a law, making it compulsory for bakers to use composite flour of 10 per cent cassava and 90 per cent wheat for bread production. The new regulation which came into effect, January 2005, stipulated that the large flour mills that supply flour to bakeries and confectioneries must pre-mix cassava flour with flour [4].

However, cassava farms just like the other crop farms in Nigeria are the small-scale types which are characterized by very low productivity. The crucial issue in the Nigerian agriculture is that of low productivity. The problem of declining crop productivity in Nigeria is important. Despite all human and material resources devoted to agriculture, the productive efficiency for most

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crops still fall under 60 percent [5-7]. Farmers output must therefore be expanded with existing levels of conventional inputs and technology. More than ever, farmers will have to produce more efficiently: That is produce maximal output from a given mix of inputs or use the minimum levels of inputs for a given level of output.

The agriculture problem in Nigeria therefore centers on the efficiency with which farmers use resources on their farms. It also borders on how the various factors that explain farm efficiency could be examined so as to improve the crop production in the country. This quest therefore raises research questions as to how productive is the Nigerian farm firm?. What are those factors that significantly influence farm-level productivity in the country?. To what extent do these factors improve crop production?. This study thus, examined the productivity of cassava farms in Nigeria using Kwara State, Nigeria as a case study. The study specifically identified and examined and the levels and determinants of productivity in cassava-based production systems.

A study as this has become necessary since cassava farms in the form of the cassava intercropped with other crops called the cassava-based production systems has from time immemorial been the prevalent arable cropping system in the large guinea savanna vegetation agriculture in Nigeria [2]. The predominance of the system has been occasioned by Nigeria's climate which is basically tropical and favourable for cassava production, farmer's level of technology and their socio-economic situations. Though cassava when cultivated as a sole crop results in high outputs, the greatest disadvantage of sole cropping is that in instances of pest or disease outbreaks that attacks the soled crop, the farmer usually looses a significant part of his crops and sometimes even loose all. The cassava-based form of producing cassava is therefore preferred by farmers, as it insures them against total crop losses. However producing cassava under different mixed cropping conditions will definitely impact on resource use in cassava production and consequently crops' yields. It is therefore necessary to examine the productivity of resource use in these cassava-based systems as this will help highlight those areas or variables that could be better managed to improve the productivity of cassava farms in Nigeria. Results from studies like this will be of immense benefit to farmers and stake-holders in the agricultural industry. This is more so particularly in the advent of the invitation/involvement of expatriates (South African farmers) in the agriculture of Kwara State.

MATERIALS AND METHODS

The study area and sample: The study was conducted in Kwara State, Nigeria. The state lies between latitudes 7°45 N and 9°30 N and longitudes 2°30 E and 6°25 E and covers a total land area of about 332,500 square kilometers. The state shares boundary with Ondo, Oyo, Osun, Niger and Kogi States in Nigeria and an international border with the Republic of Benin along its north-western part [18]. The mainstay of the state's economy is agriculture. More than 90 per cent of the state's rural population, who form the bulk of the state's total population, are engaged in farming. Within the state's climatic pattern is sizeable expanse of arable and rich fertile soils. The vegetation which is mainly wooded Guinea savannah is well suited for the cultivation of a wide variety of staples like Yam, Cassava, Maize, Cowpea, Fruits and Vegetables. Rice and sugarcane are significant cash crops [8-10].

The State is divided into four agricultural zones (Zones A-D) by the Kwara State Agricultural Development Project (KWADP) based on the agro-ecological and cultural characteristics of the state. Additionally, cassava is commonly produced across all the ADP zones in the state [8,10].

Based on the fore-going, albeit pertinent, information, the study sample was spread across the four KWADP zones. The sampling technique adopted thus comprised a two stage sampling procedure. The first stage involved the random selection of four villages per KWADP zone. The second stage comprised a random selection of ten (10) cassava farming households selected per village. In all, a total of one hundred and sixty (160) cassava farm households were selected and interviewed for the study (Table 1).

Analytical techniques: The gross margin and Total Factor Productivity (TFP) analysis were employed to analyse the data for the study. The gross margin analysis method was employed to determine the overall gross margin per hectare and the Net Farm Income (NFI) per hectare. The Gross Margin and net farm income were estimated as Eq. 1 and 2.

$$GM = TVP - TVC \quad (1)$$

$$NFI = GM - TFC \quad (2)$$

Table 1: Sample outlay design for the study

ADP zone	Village	No. of households
A	Gwetekuta	10
	Venra	10
	Kanikoko	10
	Kenanji	10
B	Sanbufo	10
	Akoro	10
	Tsaragi	10
	Edogi-dukun	10
C	Afeyin	10
	Ori-Oke	10
	Yakuba	10
	Ekejo	10
D	Alayin	10
	Ajegunle	10
	Gaa Powerline	10
	Kan Manu	10
Total	16	160

Source: Field survey (2006)

Where GM = Gross Margin, TVP = Total Value of Production, TVC = Total Variable Cost, NFI=Net Farm Income and TFC = Total Fixed Cost.

The Total Factor Productivity (TFP) analysis was used to estimate the productivities of major cassava-based systems in the study area while the OLS regression method was used to analyse the effects of various factors (variables) on productivity.

Total Factor Productivity (TFP) estimation: Following [11], TFP can be measured as the inverse of unit variable cost. This is so since TFP is the ratio of the output to the Total Variable Cost (TVC) as shown in Eq. 3.

$$TFP = \frac{Y}{TVC} \quad (3)$$

Where Y = quantity of output in kilogramme and TVC = Total Variable Cost in naira (N) Put alternatively,

$$TFP = \frac{Y}{\Sigma P_i X_i} \quad (4)$$

Where P_i = unit price of ith variable input and X_i = quantity of ith variable input. This methodology ignores the role of Total Fixed Cost (TFC) as this does not affect both the profit maximization and the resource-use efficiency conditions. Besides, it is fixed and as such a constant.

From cost theory

$$AVC = \frac{TVC}{Y} \quad (5)$$

Where AVC = Average variable cost in naira (N). Therefore,

$$TFP = \frac{Y}{TVC} = \frac{1}{AVC} \quad (6)$$

As such, TFP is the inverse of the AVC.

Determinants of agricultural productivity: Agricultural productivity change is explained by many factors. These factors include:

- Land and water related factors (such as farm/water course location, quality of land, sources of water, quality and quantity of water and timing of water application, etc.)
- Climatic factors (i.e. rainfall, temperature, sunshine, frost, etc.)
- Agronomic factors such as quality, quantity and timing of input application (i.e. seeds, fertilizers, herbicides, labour, etc.).
- Socio-economic factors (such as farmers' health, education, experience in farming, farm size, tenancy terms, land fragmentation and availability of credit).
- Farm management factors (i.e. adoption of modern production technologies, farm planning and management practices, etc.) [12].

Some of these factors are interrelated and the effects of some of them may be much greater than those of others and there may be locational variations in the degree of their effects on productivity. Some of these factors may be under the direct control of all the farmers. Others may be controlled by groups of other farmers, managers at the system level and policy-makers at higher levels. Yet some of these are beyond human control [13]. Various other studies have documented some of these factors. Other factors that abound in economic literature include technology, labour employment [14], education and training of farm operators [15], agro-environmental conditions [16, 17], security of land ownership rights [18] and funding which determines the maximal physical quantity of output that can be reached as well as the number and quantity of inputs required [19].

Productivity differences over time or across farming types can result from variety of factors. These factors include:

- Difference in efficiency (less than the maximum output is produced from a given input applied);
- Venation in scale or level of production over time as the output per unit of input varies with the scale of production; and
- Technical change [20].

Productivity varies over time on account of the farmer's rationality in resource use and as a consequent of economic policies, environment [21], infrastructure [22, 23], cropping systems and management practices at the plot level [24].

Based on the preceeding discussion, four factors can be hypothesized as the determinants of TFP on cassava-based farms. These factors are farm size in hectares (T_1), labour in man-days (T_2), educational status of farm household head (T_3) in years of schooling and fertilizer input in kilogrammes (T_4). To examine the influence of these factors on TFP, the linear function of the determinants [11] is specified as in equation (7).

$$TFP = b_o + \Sigma b_i T_i + E_i \quad (7)$$

All the hypothesized factors were therefore incorporated into the regression equation. The data gathered on these factors were fitted by the OLS method using diverse econometric specifications, namely, the Cobb-Douglas, semi-log, quadratic and the exponential functional forms. The model that gave the best fit was selected as the best equation.

The partial productivity estimates are the Marginal Products (MP) given as in Eq. 8.

$$MP = \partial TFP/\partial T \quad (8)$$

RESULTS AND DISCUSSION

Farming practices among the respondents: Evidence in Table 2 revealed that majority (35 per cent) of the farming households planted cassava intercropped with maize while about 29 per cent intercropped cassava with maize and guinea corn, where guinea corn was incorporated on the farms towards the harvesting period for maize. Other farmers (i.e. about 24 per cent and about 13 per cent), planted cassava intercropped with cowpea or melon, respectively. No case of the sole cassava cropping was found in the study area (Table 2). The mixed cropping practice is usually adopted by the respondents for cassava cultivation. According to them, the mixed cropping systems are the best agronomic practice that maximizes their output per land area.

Table 2: Prevalent cropping practices among the respondents

Enterprise combination	Frequency	Percentage (%)
Cassava/Maize/Guinea Com	46	28.80
Cassava/Maize	56	35.00
Cassava/melon	38	23.70
Cassava/cowpea	20	12.50
Total	160	100.00

Source: Results based on data analysis

Table 3: Summary statistics of costs and returns variables for cassava-based farm enterprises

	Cassava based system			
Variable	Cassva/Maize /Guinea Corn	Cassava/ Maize	Cassava/ cowpea	Cassava/ Melon
Cost of seed ₦ /ha	5681.41	8799.41	9817.63	7004.11
Cost of fertilizer ₦ /ha	3100.61	2819.98	3005.56	2973.49
Cost of labour ₦ /ha	60380.39	45940.68	48350.24	55569.82
Total variable cost				
TVC ₦ /ha	69162.41	57560.07	61173.43	65547.42
Average variable				
Cost AVC ₦	0.29	0.23	0.25	0.30
Total value of				
production TVC ₦ /ha	127152.23	127153.61	120614.13	119564.13
Gross margin/ha ₦ /ha	57989.82	69593.54	59440.71	54016.71
Total fixed cost				
TFC ₦ /ha	2000.41	1652.11	1819.11	1551.21
Net farm income				
NFI ₦ /ha	55989.41	67941.43	57621.60	52465.50

*Note ($1= ₦140)

Source: Results based on data analysis

Costs and returns analysis: The costs and returns variables statistics for Cassava-based farm enterprises in the study area are as presented in Table 3. Besides the primitive inputs like the hoes and cutlasses used in all the enterprises, labour cost dominated the total variable cost (about equal or greater than 80 per cent of the Total Variable Cost TVC). The net farm income results revealed that the cassava/maize enterprise had the highest net margins of N67941.43, followed by the cassava/cowpea (N57621.60), cassava/maize/guinea-corn (N55989.41) and the cassava/melon (N52465.50) enterprises respectively. The result follows since the cassava/maize enterprise

had the least costs–returns margins, followed by the cassava/cowpea, cassava/maize/guinea corn and the cassava/melon enterprises respectively. For the average variable cost AVC estimates, the estimate was least for the cassava/maize enterprise, followed by the cassava/cowpea, cassava/maize/guinea corn and the cassava/melon enterprises respectively.

Total factor productivity estimates: On the average, the TFP estimates for the cassava based systems peaked in the Cassava/Maize cropping system with average TFP indices of 4.4 (Table 4), followed by the Cassava/Cowpea (4.1), Cassava/Maize/Guinea-corn (3.5) and the Cassava/Melon (3.3) respectively.. This result follows since the Average Variable Cost (AVC) was least for the Cassava/Maize enterprise, followed by the Cassava/Cowpea, Cassava/Maize/Guinea-corn and Cassava/Melon systems respectively (Table 3). However, the relatively lower average variable cost in the Cassava/Cowpea enterprise was because Cowpea is a complimentary enterprise, which can replenish or enrich the soil with the Nitrogen produced by nitrogen-fixing bacteria in its roots. The Nitrogen can then be utilised by the Cassava intercrop. This reduces the quantity of nitrogen fertilizer needed to produce Cassava in the Cassava/Cowpea system.

Table 4: Percentage distribution of productivity indices for cassava-based farm enterprises

Indices	Cassava/Maize /Guinea corn	Cassava /Maize	Cassava /Cowpea	Cassava /Melon
2.1- 3.0	17.10	11.20	8.10	18.60
3.1- 4.0	37.70	23.80	20.10	30.50
4.1- 5.0	22.50	42.80	43.60	30.90
5.1- 6.0	20.20	16.00	22.70	15.50
6.1- 7.0	3.50	6.20	4.50	3.50
Mean	3.50	4.40	4.01	3.30
Standard Deviation	1.23	1.19	1.10	2.07
Maximum	6.56	6.70	6.91	6.10
Minimum	2.21	2.04	2.39	2.01

Source: Results based on data analysis

Table 5: Partial factor productivity estimates for the sample

Factor/Household Variable	Cassava/Maize /Guinea Corn	Cassava /Maize	Cassava /cowpea	Cassava /melon
Land	1.91	2.23*	2.10	1.81
Labour	0.63	0.80*	0.72	0.63
Fertilizer	0.93	1.19	1.21*	1.01
Educational status	1.64	1.79*	1.76	1.60

* Indicates the highest partial factor productivity estimate for each factor or variable across the enterprises

Source: Results based on data analysis

Estimates of the partial factor productivity: The partial factor productivity estimates are provided in Table 5. The estimates for the respective inputs used for the Cassava/Maize enterprise were for land (2.23), labour (0.8), educational status of household head (1.79) and fertilizer (1.19). Estimates for the production resources used in Cassava/Cowpea enterprise were in the same range as for the Cassava/Maize intercrop. That is, for land (2.10), labour (0.72), educational status of household head (1.76) and fertilizer (1.21); while for the remaining enterprises, the partial factor productivity estimates were relatively less. Specifically, for the Cassava/Maize/ Guinea-corn enterprise, the partial factor productivity estimates were for land (1.91), labour (0.63) educational status (1.64) and fertilizer (0.93) while the estimates for the Cassava/Melon enterprise were land (1.81), labour (0.63), educational status (1.60) and fertilizer (1.01);. On the whole, the Cassava/Maize enterprise had the highest factor productivities for the land, labour and education of household head variables, while the Cassava/Cowpea enterprise had the highest partial productivity for the fertilizer variable (Table 5).

Determinants of total factor productivity (TFP): The results of the econometric analysis of the specified regression (TFP) equation with the empirical data for farming households in the study area showed that the TFP for all the Cassava-based cropping systems were influenced significantly and positively by the hypothesized determinants (Table 6). Besides, the R^2

Table 6: Double-log estimates of OLS equations for the determinants of total factor productivity in the cassava-based cropping systems

Cassava-based Systems	Constant	Land	Labour	Educational status	Fertilizer	R^2	F
Cassava/Guinea-corn/Maize	-0.0245 (0.308)	4.842 (13.743)*	4.002 (13.373)*	7.365 (4.535)*	0.188 (7.016)*	0.758	261.87
Cassava/Maize	1.897 (0.421)	223.11 (4.12)*	5.422 (6.940)*	0.120 (2.154)*	0.537 (4.131)*	0.718	197.50
Cassava/Cowpea	0.93265.12 (3.521)	1612.1 (6.81)*	115.902 (9.005)*	412.17 (3.411)*	2326.2 (2.116)*	0.902	155.20
Cassava /Melon	28131.82 (1.240)	2249.264.123	8162.70 (2.305)	4325.12 (3.125)*	2228.1 (3.824)*	0.760	159.60

Note: *Coefficient significant at 10 per cent level, Source: Results from data analysis

values for all the Cassava-based systems were high, ranging between 0.72 and 0.90. Thus, the included variables explained sizeable proportions of the variations in the productivity levels recorded in the Cassava-based systems.

CONCLUSION AND RECOMMENDATIONS

This study assessed the productivities of cassava-based farms in the Guinea Savannah ecology,using Kwara State, Nigeria as a case study. The study findings revealed that the cassava/maize enterprise had the highest net margins of N67941.43, followed by the cassava/cowpea (N57621.60), cassava/maize/guinea-corn (N55989.41) and the cassava/melon (N52465.50) enterprises respectively. The Cassava/Maize enterprise with a 4.4 TFP level was the most prevalent and most productive cassava-based enterprise. This was followed by the Cassava/Cowpea (4.1), Cassava/Maize/Guinea-corn (3.5) and the Cassava/Melon systems with 3.3 TFP level. The study also revealed that land, labour, the educational status of the household head and fertilizer significantly influenced productivity levels in Cassava-based farms. Therefore, to achieve increased yield per cost outlay for the popular Cassava-based production systems, the following suggestions are proffered:

Efforts at reducing labour usage in the cassava-based production systems should be enbanced. This could be achieved via researches. In this vein all researches on cassava should take cognizance of the local cassava-based cropping mix of farmers. Also the rural people who are mostly the farm households should be encouraged to appreciate education. There is an urgent need to ensure easy access of farmers to education. Education was revealed to significantly affect the productivity of cassava-based farms. When farmers are educated, they can better appreciate improved technologies and even use them appropriately, thereby enhancing better resource use. Efforts at mobilizing farmers into viable cooperative groups should also be pursued vigorously. This will help mobilize rural savings that can be readily available to the farmers. Farmers, if capacitated financially can easily afford necessary inputs like the fertilizer, which was shown to significantly influence cassava-base production systems. In addition land and labour saving technologies should be researched into and extended to farmers.

REFERENCES

1. Food and Agricultural Organisation (FAO) 2000. Agriculture Towards 2015/30.Technical Interim Report. April, 2000. Rome
2. Food and Agricultural Organisation (FAO), 2004. Fact sheet No 5 on International Year of Rice http://www.rice2004.org/
3. Root and Tubers Expansion Programme (RTEP), 2002. Root and Tubers Expansion Programme. Project Facilitation Team (PFT) Workshop Held in August, 2002.
4. Technical for Agricultural and Rural Cooperation (CTA), 2005. Cooperation for Agricultural Development in ACP Countries. SPORE 118. August, 2005.
5. FACU 1992. Proceedings on the 4th Annual national Farming Systems. Research and Extension Workshop. Federal Agricultural Coordinating Unit (FACU) Reports, Ibadan.
6. Federal Department of Agriculture (FDA), 1993., Food security and Nigeria agriculture, Water Resources and Rural Development. Abuja, Nigeria
7. Federal Department of Agriculture (FDA)., 1995. Federal Department of Agriculture; Federal Ministry of Agriculture Reports. Abuja, Nigeria.
8. Kwara State Ministry of Information., 2002. Kwara State Diary 2002, pp: 1-10.
9. National Cereal Research Institute (NCRI), 1997. Rice Production in Nigeria: Problems and Prospects. National Cereals Research Institute (NCRI) Report, 1997, Badeggi, Nigeria.
10. Encyclopedia Britannica, 2003. Kwara" Encyclopedia Britannica. Deluxe Edition CD-Rom.
11. Key, N. and W. Mcbride, 2003. Production Contracts and Productivity in The US Hog Sector". Am. J. Agric. Econ., 85 (1): 121-133.
12. Hussain, I. and I.R. Perera, 2004. Improving Agricultural Productivity through integrated service provision with public. Private-Sector Partnership. Working Paper 66. Columbia. Sri Lanka: International Water Management Institute.
13. Rahman, S.A., 2003. Agricultural Biotechnology: A Prospect for Food Security in Africa. Paper Presented at the 37th Annual Conference of the Agricultural Society of Nigeria (ASN) Held at the University of Calabar 16-20 November, 2003.
14. Piana, V., 2001. Productivity. Economics Web Institutes. Downloaded at http://www. economiswebinstitute. org/main htm on 2nd February 2007.

15. Stefanon, S. and S. Saxena, 1988. Education, Experience and Allocative Efficiency: A Dual Approach. Am. J. Agric. Econ., 2: 338-345.
16. Gorton, M. and G. Davidova, 2004. Farm Productivity and Efficiency in the CEE Applicant Countries. A Synthesis of Results. J. Agric. Econ., 30: 185-250.
17. Benjamin, D., 1995. Can Unobserved Land Quality, Explain the Inverse Productivity Relationship?. J. Develop. Econ., 1: 51-84.
18. Christiou, A., 2001. Technical Efficiency and its Determinants in Romanian Farming During Transition. Imperial College at Wye. Unpublished Mmimeo.
19. Huffman, W.E. and R.E. Evenson, 2003. New Econometric Evidence on Agricultural Total Factor Productivity Determinants: Impact of Funding Sources. Working Paper. 03029, Department of Economics Papers Series. Iowa State University. pp: 1-30.
20. Ahearn, J., J. Yee, V.E. Ball and O. Nehring, 1998. Agricultural Productivity in the United States. USDA.. Economic Research Service. Agric. Inform. Bull., No. 740. January 1998.
21. Kaur, M. and M.K. Sekhon, 2005. Input Growth, Total Factor Productivity and the Components in Punjab Agriculture. District-wise Analysis. Ind. J. Agric. Econ., 60 (30): 473-482.
22. Fousekis, P. and C. Pantzor, 2000. Public Infrastructure and Private Economic Performance: Alternative Measures with an Application to Greek Agriculture. Intl. Rev. Econ. Business, 11: 111-128.
23. Matmatzakis, E.C., 2005. Public Infrastructure and Productivity Growth in Greek Agriculture. J. Agric. Econ., 29: 169-180.
24. Alene, D.A. and M.R. Hassan, 2003. Total Factor Productivity and Resources use Efficiency of Alternative Cropping Systems in Two Agro-Climatic Zones in Eastern Ethopia. Agric. Econ. Rev., 4: 2.
00. National Cereal Research Institute (NCRI), 1984. Steps to Grow Lowland Rice. Agricultural Extension and Research Laison Services. National Cereal Research Institute (NNCRI) Report.1984 Badeggi. Nigeria.