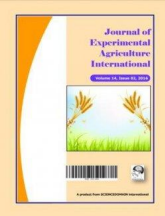

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Analysis of Farm Productivity in Integrated Tree Cropping Systems of Southwestern Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors BJA, ASB and ADK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ADK and AO managed the analyses of the study and the literature search. Author IL supervised the execution of the work at the fields. All authors read and approved the final manuscript.

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ABSTRACT

After 1971 seasons, Cocoa and other tree crops production have declined substantially in recent times owing to several agricultural complex constraints which have affected the production of the farmers and the sustainability of agricultural production. Productivity is the main determinant of sustainable agricultural production. Thus, this study investigates the farm productivity in integrated tree cropping system in Southwestern Nigeria. A multistage sampling procedure was used to elicit information from 250 farmers. Data were analysed with the use of descriptive statistics, total factor productivity and multiple regression model. Descriptive statistics revealed that the farmers have organized social groups with average age of 50.18(± 13.50) years in Lagbedu, 51.52(± 11.72) years in Iwara, 52.58(± 13.75) years in Osunwoyin, and 55.12(± 15.56) years in Akindele. Farmers' experience in farming was 26.48(± 13.4) years in Lagbedu, 29.54(± 15.79) years in Akindele, 29.9(± 14.41) years in Iwara, and 30.3(± 16.15) years in Osunwoyin. An average household size was

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9.04(± 4.38) persons in Osunwoyin, 9.26(± 6.33) in Lagbedu, 10.12(± 5.21) persons in Iwara, and 10.34(± 5.97) persons in Akindele. Majority of the household cultivate cocoa in the study area. Majority of the respondents identified inadequate funds, land issues, non-availability of agro-inputs, pests and diseases infestation as major constraint to production. The average productivity level was 0.61 kg/₦ in the study area. The determinants of farm productivity in the study area were farm size ($p<0.1$), improved varieties ($p<0.01$), hired labour ($p<0.01$), fertilizers ($p<0.01$) and extension visit ($p<0.05$). In accordance with the findings of the study, intensive teaching programmes on the use and advantage of improved seed varieties and fertilizer by virile extension services should be encouraged as well as providing input as form of credit.

Keywords: Productivity; cropping system; crop combination.

1. INTRODUCTION

The traditional agricultural cropping system of forest zone of southwestern Nigeria are based on growing crops in mixtures, a system most commonly referred to as mixed cropping [1]. The system has long been recognized as a common practice among subsistence small-scale farmers in the traditional semi-intensive system of the tropics characterized by low-input, small land size [2], lack sufficient capital with plentiful labour [3,4,5].

Crop combination are of several permanent tree crops, (cocoa (*Theobroma cacao*), oil palm (*Elaeis guineensis*), Kola nut, walnut as well as plantain/banana, arable farmland located around the vicinity of the homestead or at another farm location. In recent time, arable-permanent crops in mixture is mostly being preferred in the forest zone. The concept of mix cropping according to [6] is to bring together, crops with different maturity time, architecture, nutrient requirement etc into a mixture at the same time, under the same management for maximum utilization of nature for the benefit of man.

Despite the importance of intercropping permanent crops with other category of crops, cocoa production, a major cash crop in southwestern Nigeria have been observed to decline substantially in recent times owing to several agricultural complex constraints which have affected the total farm outputs of the farmers. The need to carry out an on-farm survey to identify the constraints and determine the farm productivity with its determinants becomes imperative in order to suggest likely improvement strategy that could improve productivity in tree cropping system in Southwestern. Consequently, this study investigates farm productivity in integrated tree cropping systems of Southwestern Nigeria. Specifically, it describes the socio-economic characteristics of farmers; identifies the types of crops grown; identifies the constraints to production in integrated tree cropping system; and determines the levels of farm productivity and determinants of farm productivity.

2. MATERIALS AND METHODS

A multi-stage sampling approach was used to select farmers in the process of surveying the on-farm productivity and constraints that have been inimical to improving tree crops production among small holder farmers. Two states were purposively selected from the southwestern Nigeria where integrated tree cropping system is practiced. A total of five local governments and subsequently five growing communities were purposively selected from each of the states based on integrated tree cropping system practiced in the area. Five farmers were randomly selected from each of the communities to have a total of 250 smallholder farmers.

2.1 Analytical Technique

2.1.1 Descriptive statistics

Descriptive statistics was used to describe the socioeconomic characteristics of farmers, identify the types of crops grown and constraints to production in integrated tree cropping system.

2.1.2 Total factor productivity

Production requires combination of inputs. This consequently reflects in productivity. Productivity measures the rate of technical change in production [7]. Productivity is the ratio of the value of total farm output to the value of the total inputs used in farm production. Following [8] approach, the productivity of a farmer was determined using the following formula:

$$TFPi = Yi / \sum PiXi \quad (1)$$

where, TFPi = total factor productivity (Kg/₦); Yi = quantity produced (Kg); Pi = unit price of variables input (₦); Xi = quantity of variables input used.

2.1.3 Multiple regression model

Multiple regression model was used to determine the factors influencing the farm productivity in integrated tree cropping system. The double log model is specified as follows:

$$\ln TFPi = a_1\ln X_1 + a_2\ln X_2 + a_3\ln X_3 + a_4\ln X_4 + a_5\ln X_5 + a_6\ln X_6 + a_7\ln X_{27} + a_8\ln X_8 + a_9\ln X_9 + a_{10}\ln X_{10} + a_{11}\ln X_{11} + a_{12}\ln X_{12} + ei \quad (2)$$

where, TFPi is total factor productivity (Kg/₦); X_1 is sex of respondent (male=1, female=0); X_2 is age of the farmers (years); X_3 is years of education; X_4 is fertilizer used (Kg); X_5 is improved varieties used (Yes = 1, No =0); X_6 is farm size (ha); X_7 is years of farming experience; X_8 is land tenure (own land=1, otherwise= 0); X_9 is household size (#); X_{10} is hired labour (manday); X_{11} is family labour (person day); X_{12} is number of contact with extension agent (#); X_{13} is primary occupation (1= farming, 0= otherwise); X_{14} is Access to credit (access=1, otherwise= 0); ei = Error term.

Rationale behind the inclusion of these variables in the model was based on a prior expectation of variables. These variables are expected to influence productivity among smallholder farmers. In productivity studies, influence of hired labour is controversial. Increase in hired labour could increase cost of production, thereby decreasing productivity or otherwise. Labour shortages may be responsible for high costs of production at times. Education encourages the adoption of productivity enhancing technologies and efficient farm management practices. Also, education provides farmers with skill and more responsive to risk. It is assumed to positively influence productivity [9]. Use of high-yielding, disease resistant and early maturing, brings relative high returns to investment when compared with the local varieties [10,11]. Land tenure was hypnotized to increase productivity [12]. Land tenure refers to the right a farmer has over land. Farmers can use land to secure loans required for productivity thus enhancing investments [13]. Farm size was hypnotized to increase productivity [14 and 15]. Increased productivity could be as a result of economies of scale [13]. Due to labour intensive nature of agriculture, male farmers are expected to be more productive than their female counterpart. Family labour means the availability of economically active labour in the household. It is assumed that family labour would increase the productivity of farmers [13]. Fertilizer was assumed to increase productivity. Access to credit facilities enables the farmers to purchase improved varieties and other technologies, hence increase productivity at farm level [13]. Extension service introduced farmers to new better methods of improving productivity, hence increase productivity.

Table 1. Description of the independent variables used in productivity model

Variables	Units	Expected signs
Age	Years	±
Education	Years spent in school	+
Land tenure status	Access; yes=1, no =0	±
Farming experience	Years	±
Farm house hold size	Number of members	±
Extension visit	Yes=1, No=0	+
Membership of association	Member=1, Non- member=0	+
Access to credit	Access; yes=1, no=0	+
Farm size	Hectares	±
Gender of house hold head	Female=0, Male= 1	±
Fertilizer	Kg	+
Improved varieties	(Yes = 1, No =0)	+
Hired labour	Man-day	±
Family labour	Man-day	±
Primary occupation	(Yes = 1, No =0)	+

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics of the Respondents

The socio-economic characteristics of farmers were presented in Table 2. There were variations in the average age of the respondents within the range of 50 years across the four communities. For example, 55.12(± 15.56) years in Akindele, 50.18(± 13.50) years in Lagbedu, 52.58(± 13.75) years in Osunwoyin, and 51.52(± 11.72) years in Iwara. This could indicate that an average farmer is relatively old in the study area. This conforms to the study of [16]. The mean household size of respondent across communities falls within the range of 9 to 10 members with Akindele (10.34 ±5.97) persons having the highest number of household members. This reiterates the fact that household is the major supplier of labor to agriculture. This agrees with the findings of [17]. The average years of schooling in the study area ranged from 6.0(±5.07) years to 6.70 (±4.99) years. This implies that the literacy level of sampled farmers was relatively high. Education could help to achieve high level of productivity. This aligns with the study of [18]. Farmers in Osunwoyin (30.3 ±16.15 years) have numerous years of farming experience in farming than farmers in other communities. This could boost their agricultural productivity. This finding agrees with [19]. Farmers in Lagbedu (9.51±6.04 ha) recorded the highest number of farm size in the study area. This could indicate that enough farmland to experiment productivity enhancing technologies. Majority of the sampled farmers have organized social group. Across the villages, farmers in Lagbedu recorded the highest (82%), farmers in Iwara (78%), Akindele (66%) and the smallest Osunwoyin (46%). Membership of a social group allows interactions among members in terms of the information dissemination [20].

3.2 Crops Grown in Integrated Tree Cropping System

Globally, there were different crop enterprises grown in the study area as shown in Table 3. Across the villages, the major crop grown is cocoa. In Akindele village, other crops grown in decreasing order of importance are cassava, yam, plantain/banana, oil palm and maize. In Lagbedu village in Ogo-Oluwa LGA of Oyo state, crops grown in descending order of importance are cassava, yam, cashew, oil palm, maize e.tc. Other crops grown in Iwara include walnut, pineapple, mango, rice, pear, bitter-kola, pepper, coffee, okro and cashew. Others crops grown in Osunwoyin village includes oil palm, cassava, maize, yam, cocoyam, tomato, vegetables, plantain, soybean and kolanut/bitter-kola, orange, cowpea, cashew, pineapple and pepper.

3.3 Constraints to Production in Integrated Tree Cropping system

Constraints to production in the integrated tree cropping system was presented in Table 4. The three main constraints among problems listed were inadequate funds, land issues and non-availability of agro-inputs in Iwara; pests and diseases, low productivity/yield and poor quality pesticides in Osunwoyin; termite infestation, financial problems and die-back disease were identified in Akindele, and marketing, funds and diseases in Lagbedu. Identified areas of intervention in Lagbedu are: provision and multiplication of disease-free improved cocoa seedlings. In Osunwoyin, promoting high-yielding vegetable crops and appropriate agro-inputs

Table 2. Socioeconomic characteristics of the farmers

Variables	Field site			
	Osun state		Oyo state	
	Iwara	Osunwoyin	Akindele	Lagbedu
Age (years)	51.52(11.72)	52.58(13.75)	55.12(15.56)	50.18(13.50)
Household size (#)	10.12(5.21)	9.04(4.38)	10.34(5.97)	9.26(6.33)
Years of formal education	6.70(4.99)	6.18(6.04)	6.0(5.07)	6.98(4.28)
Years of farming experience	29.9(14.41)	30.3(16.15)	29.54(15.79)	26.48(14.5)
Total farm size (ha)	8.37(7.72)	9.02(6.88)	7.64(6.17)	9.51(6.04)
Membership of cooperative (%)	78	46	66	82

Figure in parenthesis () represents standard deviation
Source: Data analysis, 2015

Table 3. Crops grown in integrated tree cropping system by order of importance

Ranking of crops	Field Sites			
	Osun state		Oyo state	
	Iwara	Osunwoyin	Akindele	Lagbedu
1st	Cocoa	Cocoa	Cocoa	Cocoa
2nd	Cassava	Oil palm	Cassava	Cassava
3rd	Yam	Cassava	Yam	Yam
4th	Maize	Maize	Plantain/banana	Cashew
5th	Oil palm	Yam	Oil palm	Oil palm
6th	Plantain/banana	Cocoyam	Maize	Maize
7th	Kolanut	Tomato	Orange	Orange
8th	Orange	Vegetables	Kolanut	Guinea corn
9th	Cocoyam	Plantain	Walnut	Tomatoes
10th	Walnut	Soybean	Watermelon/Cucumber	Vegetables
11th	Pineapple	Kolanut/Bitter-kola	Pepper	Pepper
12th	Mango	Oil palm	Pineapple	Groundnut
13th	Rice	Orange	-	Cowpea
14th	Pear	Cowpea	-	Pineapple
15th	Bitter-kola	Cashew	-	Cucumber
16th	Pepper	Pineapple	-	Kolanut
17th	Coffee	Pepper	-	Plantain/banana
18th	Okro	-	-	-
19th	Cashew	-	-	-

Source: Data analysis, 2015

were listed as potential areas of intervention. In Iwara, capacity building of farmers through training on the efficient use of farm resources and how best to source for funds, encouraging increased land allocation to crop enterprise activities that result from an optimal farm plan, and providing access to improved crop varieties for cocoa, maize and cassava are the main areas of immediate intervention. In Akindele, raising seedlings, preventing post-harvest losses by using recommended preservatives and embarking on value addition processing activities, and increasing their involvement in profitable enterprises were identified areas of intervention. Farmers' interest in livestock keeping, particularly poultry production, as well as fish production was also noted in all the field sites.

3.4 Productivity Level in the Integrated Tree Cropping System

Farmers' productivity levels in the integrated tree cropping system were presented in Fig. 1. An average level of productivity was observed to be 0.61 Kg/₦ in the study area. Majority (90.5%) of the respondents had productivity levels of less than 1 Kg/₦. This implies that the farmers were not productive at the time of the study. Hence, the little returns to their investments in the integrated tree cropping system.

3.5 Determinants of Level of Productivity in the Integrated Tree Cropping System

Table 5 reveals the factors affecting the level of productivity among farmers in the integrated tree cropping system. Farm size ($p<0.1$), use of improved varieties ($p<0.01$), hired labour ($p<0.01$), fertilizers ($p<0.01$) and extension contact ($p<0.05$) significantly influenced level of productivity among farmers. The coefficients of farm size ($p<0.1$), extension contact ($p<0.05$) and hired labour ($p<0.01$) were positive. This implies a unit increase in farm size, extension contact and hired labour increases the level of productivity by their magnitude of coefficient; 0.57, 0.01 and 0.006 units, respectively. The coefficients of improved varieties and fertilizers were negatively signed. This suggests that a unit increase in the use of improved varieties and fertilizers decreases level of productivity by the magnitude of their coefficients; 2.25 and 0.77 units, respectively. This could be traced to low level of education among the farmers in the study area. Lack of technical expertise and capacity building on the use of the technologies would lead to inappropriate use of improved technologies which result into decreased productivity. This may be that the farmers do not receive adequate and necessary information from extension agent.

Table 4. Constraints to production in the integrated tree cropping system

S/No.	Field sites				Ranking of constraints
	Osun State		Oyo State		
	Iwara	Osunwoyin	Akindele	Lagbedu	
1	Inadequate funds	Pests and diseases	Termite infestation	Marketing (price)	1st
2	Land issues	Low productivity/yield	Financial	Financial	2nd
3	Non-availability of agro-inputs	Poor quality pesticides	Die back disease	Disease	3rd
4	Marketing problems	Black pod disease	Lack of seedlings	Politics	4th
5	Pests and diseases	Low quality seedlings	Stem borers	Pests/ parasites	5th
6	Lack of skill	Low production scale	Defoliators	Seedlings	6th
7	Poor roads	Post-harvest processing	Black pod disease (Cherelles)	Access to land	7th
8	Post-harvest processing (flash dryer)	Marketing	Inadequate labour	Bush burning	8th
9	No improved varieties	-	Post-harvest processing	Post-harvest processing	9th
10	-	-	Improper packaging of produce	-	10th

Source: Data analysis, 2015

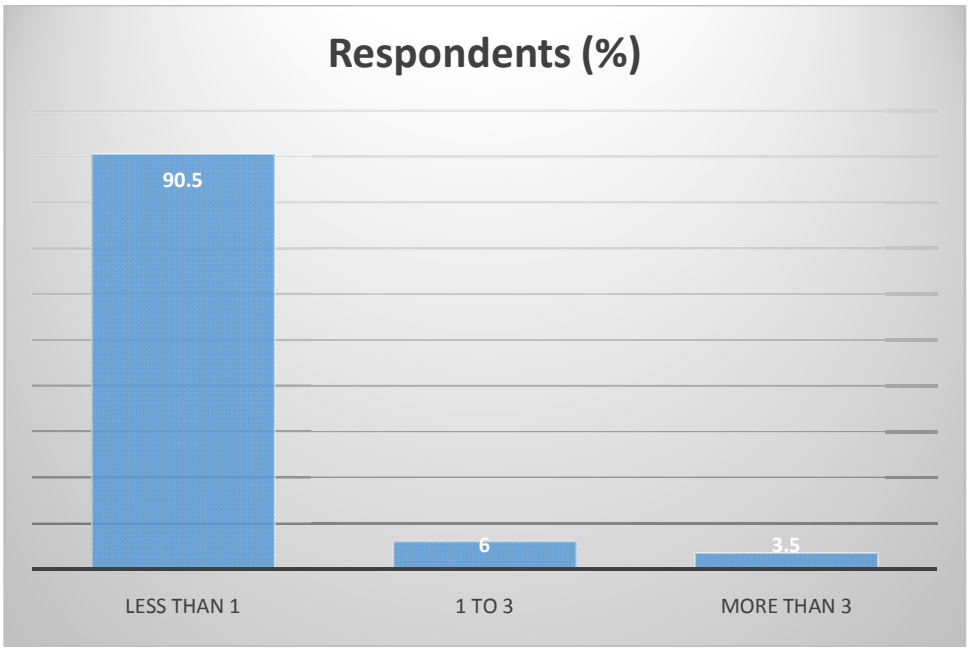

Fig. 1. Levels of productivity
Source: Data analysis, 2015

Table 5. Determinants of total farm productivity in the integrated tree cropping system

Variable	All respondents (n=200)
Age (years)	-0.9586 (0.98)
Household size (#)	-0.5359 (1.02)
Education (years)	0.399 (1.19)
Farm experience (years)	-0.711 (1.17)
Primary occupation (%)	-0.072 (0.11)
Farm size (ha)	0.572 (1.74)*
Improved seed (kg)	-2.254 (3.58)***
Hired labour (%)	0.005 (3.06)***
Family labour (Man-day)	-0.580 (1.52)
Fertilizer (kg)	-0.770 (5.93)***
Land tenure (%)	0.367 (0.18)
Extension contact (%)	0.005 (2.02)**
Access to credit (%)	-2.497 (1.35)
R-square	0.370
Adjusted R-square	0.323
F-value	7.77

**** very highly significant at 1%, ** highly significant at 5%, * significant at 10%*
Figures in parentheses ( ) represent t-values.
Source: Data analysis, 2015

4. CONCLUSION

Majority of the sampled farmers are old, experienced, and have organized social group. Cocoa is the major crop grown by the farming households in Southwestern Nigeria. The main constraints to production were inadequate funds, land issues, non-availability of agro-inputs, pests and diseases, poor quality pesticides, termite infestation, financial problems, among others. The study concluded that the farmers were not productive at the time of the study. Farm size ($p<0.1$), use of improved varieties ($p<0.01$), hired labour ($p<0.01$), fertilizers ($p<0.01$) and extension contact ($p<0.05$) significantly influenced level of productivity among farmers. These variables were the policy variables that could influence productivity among cocoa farmers in the study. Therefore, intensive teaching programmes on the use and advantage of improved seed varieties and fertilizer by virile extension services should be encouraged as well as providing input support services in the form of credit.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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