

Effect of Land Fragmentation on the Productivity of Rice Farmers in Osun State, Nigeria

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ABSTRACT

Presently in Nigeria, a large proportion of the population depends on imported rice as locally made rice are not produced in large quantity that can feed the whole populace. The fragmentation index of the study area is 0.86 which means that rice farmers in Osun State operate on many scattered plots and they have an average farm size of only 0.53 hectares. Multi stage sampling technique was used in selecting respondents for the study. Simple random sampling was used to select rice farmers through their association in each of their local government areas. A hundred and fifty-three respondents were used. Data were collected with the means of well-structured questionnaire. Data were analyzed using descriptive statistics, Ordinary Least Square (OLS) Model, Net Margin Analysis and the Cobb-Douglas Production function. This study reveals that years of education(-0.0063731), average plot size(-0.0729282) and distance of plots to homestead(-0.1432701) have significant effect on land fragmentation among rice farmers in Osun State while other variables such as sex(0.611602), age(0.000867), years of farming(-0.0016231), household size(0.0098885), average distance between plots(0.0457988) and access to extension services(-0.0310289) do not have a significant effect on land fragmentation among rice farmers in the study area. This study further revealed that land fragmentation (20.1697), labour cost (0.0002481), quantity of seed (0.0943123) and fertilizer used (0.3799082) has a positive and significant effect on the productivity of rice farmers in the study area whereas other variables like the average distance between plots, average distance between plots and homestead, years of farming and the level of education of the rice farmers has no effect on their productivity. Land fragmentation has a great influence on the productivity of rice farmers in Osun State. It was recommended that the farmers should use improved variety of seeds and not the local varieties to increase their production as the government creates more awareness on rice production by organizing seminars and workshops for the unemployed youths and encouraging them to go into rice production.

Key words: Cobb-Douglas Production function, Land Fragmentation, Net Margin Analysis, Productivity

INTRODUCTION

Besides the oil sector which is highly focused due to its contribution to the economy of Nigeria, the agricultural sector is the next important with the sector been the single largest employer of labour of about 70% of the country's total workforce (USDA, 2013; NBS, 2014). The agricultural sector in 2010 contributed about 40.07% and 22% in 2014 of Gross Domestic Product (GDP) for both pre and post debasing respectively (NBS, 2014).

Bentley (1987) defined land fragmentation as the situation in which a single farm or ownership consists of numerous spatially separated plots. Bizimana *et al.* (2004) also noted that land fragmentation refers to farmers operating two or more geographically separated tracts of land, taking account of the distances between those parcels. According to Gonzalez *et al* (2007) and Demetriou *et al* (2013), some problems are believed to be associated with land

fragmentation but those that are prevalent are the small size, irregular shape and dispersion of parcels. But Kadigi *et al.* (2017) pointed out that due to the current trend of rural development, land use for farming is becoming scarce as against what is obtainable in past years when land fragmentation was declining with farm size, and parcels located closer to homestead were more fragmented than the ones located afar.

Rice is the most consumed staple food by the Nigerian populace across states and geo-political zones. Rice, (Genus *Oryza*) is tolerant to desert, hot humid, flooded, dry and cool conditions and grows in saline, alkaline and acidic soils. Osun State is not an exception in sustainable rice-based production systems which can help the eradication of world hunger and achieving the United-Nations (UN) Millennium Goals. Upland rice is planted between April

and June for the Savannah Zone and between March and April for the Forest Zone. The lowland rice is planted between July and August. Osagie in 2014 pointed out that Nigeria currently spends about a billion Naira daily importing rice, a development helping farmers in countries like USA, India, and Thailand where Nigeria mostly imports rice to increase their production while rendering farmers in Nigeria redundant. The United States Department of Agriculture in 2014 reveals that, Nigeria's rice imports in 2012 to 2013 alone were estimated to reach about 3 million tonnes.

Land tenure systems in operation in the study area affect agricultural productivity by influencing the efficient use of inputs and the adoption of modern technology. The development of agriculture sector is very much urgent for poverty reduction and sustainable development of the country and most especially because of the presence of land fragmentation in the study area.

The two most popular integrated indicators are the Januszewski index (JI) and the Simpson index (SI) (Blarel *et al.*, 1992).

The Januszewski index is within the range of 0 to 1. The smaller the JI value, the higher the degree of land fragmentation. It has three properties: fragmentation increases (the value of the index decreases) when the number of plots increases, fragmentation increases when the average plot size declines, and fragmentation decreases when the inequality in plot sizes increases. The index, however, fails to account for farm size, plot distance, and shape of plots.

$$JI = \frac{\sqrt{\sum_{i=1}^n a_i}}{\sum_{i=1}^n \sqrt{a_i}} \dots \dots \dots (1)$$

Where n is the number of plots and a_i is the area of each plot. This index is located within the range of 0 to 1. The higher the JI value, the lesser the degree of land fragmentation.

The Simpson index (SI) resembles, to some extent, Januszewski's index. It measures the degree of land fragmentation. The Simpson index also is ranged between 0 and 1. Contrary to the JI, a higher SI value corresponds with a higher degree of land fragmentation.

$$SI = 1 - \frac{\sum_{i=1}^n a_i^2}{\left(\sum_{i=1}^n a_i\right)^2} \dots \dots \dots (2)$$

The choice of appropriate measures deserves much attention due to its importance in quantitative analyses of land fragmentation.

The main causes of land fragmentation in Nigeria may be cited as partial inheritance and land shortage. Traditional inheritance practices of transferring property especially land to all children in each generation has, over time, divided land in Nigeria into increasingly smaller holdings. The present situation of the country calls for a serious approach in tackling food insecurity. The population of the country is increasing geometrically by the days but there is no enough food to meet up with the challenge. Even when we have committed farmers that may be interested in going into production, there are no incentives for them. There is no means of going into large scale production since they don't have access to credit facilities and even when they do, the banks or lending institutions demand for collaterals the farmers can never afford.

Land fragmentation is believed to hamper productivity of rice in a number of ways. Fragmented lands can increase transport costs as farmers move from one plot to the other, hinderance of economies of scale and farm mechanization and banks unwillingness to take small, scattered plots as collateral, which prevents farmers from obtaining credit to make investments. These challenges are in line with studies earlier carried out in developing and developed countries which revealed that land fragmentation affects the performance of farmlands (Tan *et al.*, 2010), cost and benefit of the farmlands (Kawasaki, 2010), the technical efficiency of farmers (Rahman & Rahman, 2008) and profitability of the farmers (Di Falco *et al.*, 2010).

Ajetomobi *et al.* (2011) said rice production in Nigeria is not only affected by availability of land, capital, labour and management of this product but also by the efficiency of production. Hence the need to examine the factors influencing land fragmentation among rice farmers in Osun State and postulating the influence of land fragmentation on the productivity of rice farmers in the state.

METHODOLOGY

Study area

The study was carried out in Osun state. Osun State was carved out of the old Oyo State and occupies a land mass of approximately 8,602 square kilometres. It is bounded on the west by Oyo State, in the east by Ondo and Ekiti States, in the north by Kwara State and in the south by Ogun State. Osun State was carved out of Oyo State on the 27th of August, 1991. The people of the state are Yorubas and trace their origin to Oduduwa and the town of Ile-Ife. Osogbo is the capital of the state with a population of 2,203,016 (NBS, 2009). The people of the state are mostly traders, artisans and farmers.

Data collection and sampling procedure

Primary data were collected through the use of a well-structured questionnaire. The multi stage sampling

technique was employed. The first stage involved a purposive selection of Oriade, Ilesa West, Ilesa East, Ife Central, Ife North, Ife South and Ife East and Aiyedire local government areas (LGAs) based on a priori knowledge that they are rice producing LGAs in the state. The second stage involved a simple random selection of twenty (20) rice farmers from each of the local government areas through the Rice Farmers' Association. The last stage involved purposive selection of farmers planting rice on two or more geographically separated plots of land. All the selected farmers are found to operate on two or more geographically separated plots of land but only 153 responses were found complete for the purpose of this study.

Analytical Techniques Ordinary Least Squares (OLS)

This was used to look at factors influencing land fragmentation. OLS regression is one of the major techniques used to analyze data and forms the basis of many other techniques e.g. ANOVA and the Generalized Linear Models (Rutherford, 2001). OLS model is applicable because all the farmers practice land fragmentation, that is they operate on more than one plot of land. The OLS model can be written as:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \dots + \beta_{10} X_{10} \dots + u_i \dots \dots \dots (3)$$

Where:

- Y = Land Fragmentation measured by Simpson Index
- α = Intercept
- β = Slope
- X_1 = Sex of rice farmers (Male = 1, Female = 0)
- X_2 = Age of rice farmers in years
- X_3 = Years of education of rice farmers
- X_4 = Years of farming in rice by farmers
- X_5 = Household Size
- X_6 = Average plot Size cultivated by the farmer in hectares
- X_7 = Average distance between plots in kilometers
- X_8 = Distance of plot to homestead in kilometers
- X_9 = Access to extension services (Those with access = 1, Those without access = 0)
- α indicates the value of Y when all values of the explanatory variables are zero. Each β parameter indicates the average change in Y that is associated with a unit change in X, and at the same time controlling other explanatory variables in the model.

Net Margin Analysis

Net Margin = Gross Margin (GM) — Total Fixed Cost (TFC).....(4)

Where

Gross Margin = $\frac{\text{Total revenue} - \text{Total Variable cost}}{\text{Total revenue}}$ (5)

Total Revenue = No of bags of rice sold × Price.....(6)

This is an indication of how effective a farm business is at cost control. The higher the net margin is, the more effective the farm is at converting revenue into actual profit. It is also called net profit margin and it is often expressed as percentage.

The Cobb–Douglas production function.

This in its stochastic form, may be expressed as:

$$Y_i = \beta_0 X_i^{\beta_1} \beta_1 X_i^{\beta_2} X_i^{\beta_3} X_i^{\beta_4} X_i^{\beta_5} X_i^{\beta_6} X_i^{\beta_7} \dots X_i^{\beta_{12}} e^{u_i} \dots \dots \dots (7)$$

This non-linear form of Cobb-Douglas model was transformed into linear form by taking natural logarithms on both sides of the equation. This then becomes:

$$\ln Y_i = \ln a + b_1 \ln X_{1i} + b_2 \ln X_{2i} + b_3 \ln X_{3i} + b_4 \ln X_{4i} + b_5 \ln X_{5i} \dots b_{12} \ln X_{12i} + U_i \dots \dots (8)$$

Where:

- Y = Productivity of the rice farmers (output per hectare)
- X_1 = labour cost in mandays
- X_2 = Fragmentation Index
- X_3 = Quantity of Seed used in production
- X_4 = Quantity of fertilizer used in production
- X_5 = Average distance between plots
- X_6 = Average distance between plots and homestead
- X_7 = Sex of rice farmers where male=1 and female = 0
- X_8 = Age of rice farmers
- X_9 = Household Size
- X_{10} = Use of machineries
- X_{11} = Years of farming of rice farmers
- X_{12} = Level of education of the farmer using years of education of the farmer
- u = disturbance term
- e = base of natural logarithm
- b_1, b_2, \dots, b_{12} = Coefficients of the respective variables;
- n = Natural logarithm.

Table 1: Anticipated signs of the variables included in the Model based on the Literature

Explanatory variables	Expected sign
Simpson index	-/+
Farm size	+
Quantity of seed used	+
Quantity of Fertilizer used	-/+
Average distance between plots	+
Average distance between plots and homestead	+
Sex	-/+
Age	+
Household size	+
Use of machineries	-/+
Years of farming	+
Level of education of the farmer	-/+
Labour cost	-/+

RESULTS AND DISCUSSION

Characteristics of Rice Farmers practicing Land Fragmentation in Osun State, Nigeria.

This study revealed that all the respondents in the study area are practising land fragmentation. Only 3.27 percent of rice farmers in Osun State are female while 96.3 are male. None of the farmers is single, widowed or divorced. Only 1.96 percent of the farmers are less or equal 30 years, 4.58 percent are between 30 and 40 years, 39.87 are in the range of 41 and 50 years, farmers that are aged between 51 and 60 are 39.22 percent and 14.38 are above 60 years of age.

About 9.15 percent of the respondents are illiterates and, in the population, 58.17 percent had primary education while 32.68 percent had secondary education. A total of 62.75 percent of the respondents had spent between 1 and 30 years farming, 27.45 percent has been rice farmers for between 31 and 40 years, 8.50 percent has been into rice production for between 41 and 50 years and 1.31 percent has been into production for between 51 and 60 years. Out of the respondents, 19.61 percent have between 1 and 5 dependent family members, 74.51 percent between 6 and 10 family members and 5.88 percent had more than 10 family members dependent on them.

Table 2: Table showing the socio- economic characteristics of rice farmers in Osun state

Variables	Frequency	Percentage	Average Frag. Index
Distribution by practice of Land Fragmentation			
Female	5	3.27	0.53
Male	148	96.3	0.65
Distribution by sex			
Female	5	3.27	0.53
Male	148	96.3	0.65
Distribution by Marital status			
Single	0	0	0
Married	153	100	0.65
Widowed	0	0	0
Divorced	0	0	0
Distribution by Age			
Below 30	3	1.96	0.55
31-40	7	4.58	0.56
41-50	61	39.87	0.67
51-60	60	39.22	0.63
Above 60	22	14.38	0.67
Distribution based on level of Education			
Illiterate	14	9.15	0.65
Primary	89	58.17	0.67
Secondary	50	32.68	0.6
Distribution based on years of farming			
< 30	96	62.75	0.66
31-40	42	27.45	0.62
41-50	13	8.5	0.64
51-60	2	1.31	0.8
Distribution based on Household size			
1-5	30	19.61	0.62
6-10	114	74.51	0.65
More than 10	9	5.88	0.67
Distribution based on extent of visit by extension agents			
Weekly	49	32.03	0.65
Monthly	104	67.97	0.65
Distribution based on access to credit			
Yes	0	0	0
No	153	100	0.65

Source: Field Survey 2012

Table 3: Factors influencing Land Fragmentation among Rice Farmers in Osun State, Nigeria

Variable	Coefficient	Standard Error	t- value	P> t
Sex	0.611602	0.0574201	1.07	0.289
Age	0.000867	0.0010309	0.52	0.601
Years of Education	-0.0063731	0.0033247	-1.92*	0.057
Years of Farming	-0.0016231	0.0016451	-0.99	0.326
Household Size	0.0098885	0.0066221	1.49	0.138
Average Plot Size	-0.0729282	0.0198069	-3.68***	0
Average distance between Plots	0.0457988	0.0488308	0.94	0.35
Distance of Plots to Homestead	-0.1432701	0.0493662	-2.90**	0.004
Access to Extension Service	-0.0310289	0.023859	-1.3	0.196
Constant	0.8004799	0.1215336	6.59***	0

R – squared 0.2089; Adjusted R – squared 0.1528; Number of Observations 153

***Significant at 1%, **Significant at 5%, *Significant at 10%

Source: Computer printout of Regression Analysis, 2012

This study revealed that 32.03 percent of farmers enjoy the visit of extension agents weekly while 67.97 percent do have access to extension service on a monthly basis. It was further revealed that 100 percent of the farmers do not have access to credit facilities, meaning no rice farmer in the study area had access to credit facilities.

Factors influencing Land Fragmentation among Rice Farmers in Osun State, Nigeria.

In Table 3, the factors influencing land fragmentation among rice farmers in Osun State were shown. An adjusted R- square of 0.2089 percent indicates that 20.89 percent variation in land fragmentation index is explained by the characteristics of rice farmers and other variables.

To be specific, years of education, average plot size and distance of plots to homestead have significant effect on land fragmentation among rice farmers in Osun State while other variables such as sex, age, years of farming, household size, average distance between plots and access to extension services do not have a significant effect on land fragmentation among rice farmers in the study area.

For years of Education, a one unit increase in the years of education of the rice farmers increases the degree of land fragmentation among the rice farmers in Osun State by - 0.0063731 units. This means that the more educated they are the more the degree of land fragmentation will be in the study area.

For average Plot Size, a one unit increase in the average plot size of the rice farmers in Osun State increases the degree of land fragmentation by -0.0729282 units. This in turn will increase the number of plots used for planting rice, in other words increase in the degree of land fragmentation.

For distance of Plots to Homestead, a one unit increase in the distance of plots to homestead of the rice farmers in Osun State increases the degree of land fragmentation by - 0.1432701units. When the homesteads are not far from the plots, the rice farmers will increase the number of plots used

for rice production. This we can say have a significant influence on land fragmentation.

Table 4: Table showing the Net Margin of Rice Production in Fragmented Areas in Osun State

Cost Item	Average Cost (Naira)
Land Clearing cost	25934.64
Planting cost	24744.97
Weeding cost	24873.27
Harvesting cost	22897.06
Packaging cost	8220.26
Transportation cost	10217.7
Cost of seeds	3382.29
Fertilizer cost	339.87
Total Average Operating Expenses	120610.06
Cost of Goods Sold	78689.7
Tax	247.84
Total Cost	199547.6
Total revenue	233370.4
Gross Margin	33822.8
Net Margin	0.14

Source: Field Survey 2012

The Net Margin of Rice Production in Fragmented Areas in Osun State

From the table below, it was concluded that the rice farming business in fragmented land areas is profitable because of the percentage gotten as net margin (0.14 = 14%). This number indicates that rice farming in fragmented land areas in Osun state is at cost control even though the profit is not much. The net margin value shows the effectiveness of rice farmers at converting revenue into actual profit. This means that rice production in Osun State for now is a profitable business.

Table 5: The Influence of Land Fragmentation on the Productivity of Rice Farmers

Output	Coefficient	Standard Error	t-value	P> t
Farm size	-0.7400743	0.3617106	-2.05**	0.043
Quantity of seed used	0.0943123	0.0409331	2.30**	0.023
Quantity of Fertilizer used	0.3799082	0.0537659	7.07***	0
Cost of Labour	0.0002481	0.0000158	15.74***	0
Fragmentation Index	20.1697	6.214278	3.25***	0.001
Average distance between plots	0.1884348	3.097162	0.06	0.952
Average distance between plots and homestead	-0.9581832	3.341036	-0.29	0.775
Sex of rice farmers	-1.132379	3.663403	-0.31	0.758
Age of rice farmers	0.0758392	0.104303	0.73	0.468
Level of education	0.2732302	0.206251	1.32	0.187
Years of farming	-0.1320365	0.1036927	-1.27	0.205
Household size	-0.9338612	0.4228724	-2.21**	0.029
Use of machineries	6.442366	7.926652	0.81	0.418
Constant	6.641304	7.355499	0.9	0.368

R-squared 0.8407; Adjusted R-squared 0.8258; Number of Observations 153

***Significant at 1%, **Significant at 5% **Source:** Computer printout of Regression Analysis, 2012

Effect of Land Fragmentation on the Productivity of Rice Farmers

The estimated model yields an R- squared of 0.8407 as could be seen in Table 3. From the table, land fragmentation (20.1697) is found to have a positive and significant effect on the productivity of the rice farmers. This indicates that farms with lower Simpson Index (SI) may be able to offset the negative impact of fragmentation by adopting the use of improved seeds, modern technology adoption like the use of machineries and improved labour allocation throughout the production time.

As expected, farm size (-0.7400743) has a negative and a significant effect on the productivity of the rice farmers. The quantity of fertilizer used (0.3799082) has a positive and significant effect on the productivity of the rice farmers, as the quantity of fertilizer use increases, the productivity of the rice farmers also increases. The quantity of seed used (0.0943123) for planting has a positive and statistically significant effect on the productivity of rice farmers in the study area. It means that a one unit increase in the quantity of seed used for production increases the productivity of the farmers by 0.0943123 units.

The labour cost of the rice farmers (0.0002481) in the study area also has a significant effect on their productivity. It means there is an efficient allocation of resources. The household size (-0.9338612) of the rice farmers in the study area is also found to have a significant effect on the productivity of the rice farmers. By the coefficient, it means that as the number of household members increases, there will be a reduction in the productivity of the rice farmers and vice versa.

It was discovered that the average distance between plots, average distance between plots and homestead, sex, age, use of machinery, years of farming and the level of education of the rice farmers has no effect on their productivity.

It was discovered that the average distance between plots, average distance between plots and homestead, sex, age, use of machinery, years of farming and the level of education of the rice farmers has no effect on their productivity.

CONCLUSION AND RECOMMENDATION

Summarily, it has been revealed that more males than females are into rice production in the study area and all the rice farmers are married. There are more Christians than Muslims in rice farming in the study area and the highest percentage of farmers planting rice in Osun State are between the ages of 41 and 50. The study further revealed that they do not use machineries for their planting operations because their land is not ploughable. This study showed that effective rice farming in fragmented land areas in Osun state is not at cost control as it was discovered that land fragmentation is found to have a positive and significant effect on the productivity of the rice farmers.

It is thus recommended that the farmers should use improved variety of seeds and not the local varieties to increase their production as the government creates more awareness on rice production by organizing seminars and workshops for the unemployed youths and encouraging them to go into rice production.

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