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FARM LOCATION AND DETERMINANTS OF AGRICULTURAL PRODUCTIVITY IN THE OKE-OGUN AREA OF OYO STATE, NIGERIA

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ABSTRACT

This exploratory study empirically assesses the effects of farm location on food farmer's technical efficiency. The study was carried out in the Oke Ogun Area of Oyo State. Three Local Government Areas (LGAs) were purposively selected and a multistage random sampling technique was used to collect data from 240 food farmers. Descriptive and inferential statistics were adopted to analyse data and a Stochastic Production Frontier Approach was used to estimate farmer's technical efficiency and its socio-economic determinants. The results show that the majority of farmers traveled an average of 6 km between the farm location and the village and resided mostly in the village. Food producers were full-time farmers practicing mostly crop diversification and exploiting an average of 14.61 acres of land. The technical efficiency scores recorded varied between 0.2 and 0.94 with a mean of 0.73. There is a significant effect of the farm distance, farmers' place of residence, farmer's gender, experience, extension contact, access to credit, and rate of lands to tubers and fertilizer use on food farmers' technical efficiency. Meanwhile, the level of involvement into farming (full-time or part-time), the diversification index, and farm size had no significant effect on farmer's productivity. The study *suggests no negative impact of farm distance on food farmer's productivity while highlighting the strategic importance of credit and extension services towards female food farmers.*

Key words: Farm location, distance, farmer's residence, agricultural diversification index, Technical Efficiency, Nigeria.

INTRODUCTION

In Nigeria, the agricultural sector is the largest provider of employment in the rural area, producing the bulk of food for the country. Meanwhile, productivity is low and poverty is high due to lack of basic infrastructure, such as rural roads, transportation facilities, and other social amenities. Farmers suffer from high cost of mobility and input availability. Most of the time farmers walk long distances from their place of residence to their farm locations. These daily journeys to the farm location, with its implication on farmer's health and security, could result in low agricultural productivity.

Diverse reasons could explain the distance between the location of a farm and the place or village of residence of the farmer. These may range from demographic pressure, the search for fertile soil and land space, the need for risk minimization through crop and land diversification, etc.

Most of the time farmers devise strategies on how to minimize the effect of long distance trekking or movement on their productivity (including a decision to reside temporarily on a farm, using a transport mode, or the hiring production factors, like machineries and labor services).

Distance is an important element of agricultural production. Farm distance determines the choice of the cropping pattern and the production system adopted by farmers. According to Okafor and Fernandez (1987), the degree of business diversification and intensification would be higher on very close village gardens than the distant bush farms. The degree of fertilizers and chemicals used, for instance, would be more intense on village farms than bush plots; meanwhile, intensification would decrease as farm location from village center increases. When farmers adopt a multiple-plots strategy, specialization and fallowing are mostly practiced on farms that are located farthest away from the farmer's place of residence; while mixed cropping, farm supervision, and farm maintenance would be the practices on closest farms. According, fallowing seems to decline with increased access to farms. This is probably because of the intensification and the progressive reduction in farming space; the farthest the farm location the farmland location to the village, the larger the expected farmlands' size.

Adegboye (1976) noted that land fragmentation reduces the efficiency of labour because, with plots located at more than one site, farmers tend to spend a large percentage of the available working hours traveling from one plot to the other, thereby wasting time that could have been usefully engaged in production.

In terms of agricultural land use, Awoke and Okonji (2003) in Ebonyi State of Nigeria observed that farm location impacts negatively on land utilization, meaning land use decreases as distance increases.

In relation to the market, Hine and Ellis (2001) indicated that intensity of food production decreases as distance of farm to market increases. They also reported a general tendency for heavier crops (such as tubers) to be grown only around the farmstead and collection points, whereas high–value perennial crops (like cocoa) tend to be grown further away. It was noted also that fewer fields are put under cultivation as the distance to collection points becomes long and the transportation cost high.

In terms of productivity, Goletti *et al*. (2001) found that the distance to the nearest market, bank, road, extension service, or livestock service centre do not statistically affect farmer's productivity. The influence of distance did not show a significant impact on the net return per capita, the net return per hectare of usable land, and the net return per unit of labour.

In terms of technical efficiency effects, Bhasin (2002) noted that for onion and tomato growers - in addition to socio-economic characteristics such as age, education, and soil quality - the distance from the farm location to the home of the farmer is a significant determinant of farmer's technical efficiency. Technical Efficiency (TE) decreases as distance of farm location to farmer's home increases. But for pepper growers TE decreases only as distance to market increases. In addition, the author noted that soil fertility increases farmer's technical efficiency.

Ekbom (2001) also noted that long distances traveled by farmers to water sources reduce vegetables' productivity. Hau and Von Oppen (2002) found, in a study in Thailand, that a reduction in distance by 1 percent leads to an increase in productivity by 0.94 percent through resources re-allocation.

Alpizar (2007) found that farmer's productive performance is negatively related to distance and, therefore, concluded that reduced distance improves farmers' integration to market; while agricultural diversification, that is land and crops diversification, significantly improves the farmer's TE. Nchare (2007) found a positive, but not significant, correlation between technical inefficiency and the distance between the farmer's house and his coffee farm plot. Meanwhile the findings by Lyubov and Jensen

(1998) confirmed that distance from a farm location to the nearest city (market) is a determinant of the technical efficiency of grain producers in Ukraine.

In terms of diversification, Pingali (2004) noted that diversification, despite its advantages, increases labour requirements and supervision time on the farm, while the flexibility of farmers in responding to diversification opportunities would be constrained by market size, price uncertainty, land ownership, soil suitability, availability of irrigation infrastructure, and the availability and cost of labour. He, therefore, recommended long-term government investments in basic rural infrastructure, such as road and market construction, to ensure transition from subsistence to commercialized farming.

In terms of intensification, Hau and Von Oppen (2002) in Thailand, concluded that market access has an indirect impact on productivity through increased use of inputs. The authors found that a decrease in distance of farm to market by 10 percent, increases intensification through fertilizer and pesticide use by 5.3 percent and 0.4 percent respectively.

It could be pointed out that, there is yet to be a consensus on the relationship between farm distance and farmer's productivity. This study, therefore, contributes to the debate by empirically estimating the effect of farm distance and farm location characteristics on farmer's productivity in the Oke Ogun Area of Oyo State in Nigeria.

The objectives of this exploratory study would, therefore, be an assessment of the locations characteristics determining farmer's productivity in the study area.

Conceptual Framework

The word "distance", according to the Oxford Advanced Learner's Dictionary edited by Hornby (1995), is the "amount of space between two points". This implies other concepts like time, place, transportation mode, quality of road, etc. all of which sum to the cost of mobility. For this study, the distance from the residence of the farmer to his farm location is the amount of space the farmer travels daily between two geographical points. For a farmer residing on-farm during farming, farm distance would, therefore, take the value of zero and for a farmer residing in the village center with farms located outside the village, it is the number of kilometers between the two points. The distance from the farmer's residence to the farm location would have several effects on a farmer as an individual, his productivity, health condition, security, and efficiency. For instance, one effect is the time wasted by the farmer traveling daily back and forth as a normal routine, thereby adding to the hardship of farming. It also means an additional production cost through added transportation costs on inputs and outputs and an increase in the marketing chain with its depressive effect on the farm gate price (Olayide and Heady, 1982; Upton, 1997). In other words, the distance between the farm location and the market translates into a reduced income to the farmer. Distant farms also would impact negatively on farmer's access to family labor by increasing the level of competition between the schooling of children and farm work. In some cases, the children may have to stop going to school in order to assist on the farm or they might have to go to school while the farmers have to resort to a costly hired labor.

In the tropics, where this study was carried out, distant farm location would imply a reduction in the farmer's agricultural output due to a reduced ability to monitor farm activities coupled with the increased risk of road hazards as a result of traveling long distances to get to the farms.

MATERIALS AND METHODS

Area of the study

The study was carried out in the Oke-Ogun Area of Oyo State, Nigeria. The study area is located within the Guinea Savannah Zone (northern part of the state). The area shares borders with states like: Kwara, Niger, Ogun, Osun and Benin Republic (a neighboring country). The area is recognized as the "food basket" of the Southwestern Nigeria. The annual rainfall varies between 700-1100 mm. The people of the area are Yorubas and their major economic activities are: farming, hunting, fishing, food processing, transportation, and craft businesses. There is a limited level of infrastructural and institutional development in the study area. Most farm families in the area reside in the various settlements abounding in the villages and farmers still adopt the traditional cultivation methods. They still use traditional tools, such as cutlass, hoe, axe, and so on. Agricultural diversification is the most commonly used strategy of agricultural risk management. The prevailing bad conditions of the road network and the paucity of transport modes are easily noticeable, in addition to the long distances traveled daily by farmers from the homestead to farm locations.

Sampling and Data Collection

Three Local Government Areas (LGAs), namely Oorelope, Atisbo, and Olorunsogo, were purposively selected to conduct the study. A multistage random sampling technique was adopted to select 230 respondents from the three LGAs. First, 10 villages were randomly selected from each LGA followed by another random selection of 10 food farmers from each village, making a random sample of 240 respondents for the study. A pre-tested structured questionnaire was administered on the respondents to collect data on their socio-economic characteristics, place of residence during farming, number of farmlands exploited and location, the farm distance covered, cultivated crops, the farms' size, the inputs used, the farm enterprises combination and their land allocation to each crop, the market prices, transportation costs, and the credit access.

Methods of Analysis

Descriptive and inferential statistics were used to analyze the data. The agricultural diversification was measured (as explained below) and a two–step estimation of farmer's TE and location effects was used.

Measure of Farmer's Productive Efficiency

Farmers' productive efficiency was captured using the Composite Error Term Technique, known as the Stochastic Frontier Approach. For this, the Frontier 4.1 software, developed by T. Coelli (1996), was used to estimate individual firm's TE and the OLS technique used to assess the effects of farm location and agricultural diversification characteristics on farmer's technical efficiency.

The stochastic production function is presented as follows:

$$LnY_i = f(X_i; \beta) + \varepsilon_i$$

Or,

$$LnY_i = a_0 + a_i \Sigma LnX_i + (V_i - U_i)$$

With,

Y_i = level of output of firm i

X_i = vector of inputs used by the firm i (Rent/depreciation, Labour and capital)

a_i = technical efficiency parameters of input X used by firm i

$\varepsilon_i = V_i - U_i = \varepsilon_{ia} - \varepsilon_{ib}$ and $\sigma^2 = \sigma^2_a + \sigma^2_b$

ε_{ia} are normally distributed random variables, and ε_{ib} is a non-negative term assumed to be exponential or half-normal distributed and accounts for the controllable individual firm inefficiency component. Graphically, it is the distance between the observed and the expected output on the stochastic frontier curve. The technical efficiency is, therefore, derived as follows:

$$TEi = y_i/y^0_i$$

$$= f(X_i, \beta)\exp(\varepsilon_{ia} - \varepsilon_{ib}) \,/\, f(X_i, \beta)\exp(\varepsilon_{ia}) = \exp(-\varepsilon_{ib})$$

But, for simplicity, the parameter $\square = \sigma^2_a / \sigma^2_{\varepsilon i}$ with $0 \square \square \square 1$ will be used to capture the firm technical efficiency, with the most efficient firm scoring 1 as the TE index. Battese and Corra (1977) judged this expression as computationally preferable.

Specifically for this study,

$$Q_i = B_0 + B_1D + B_2L + B_3K + (\nu_i - \mu_i)$$

Q_i = Total output of the farm from all the crops grown. That is the sum of individual output x market price for yam, cassava, maize, sorghum, cowpea, groundnut, soya-beans and vegetables (₦)

D = Rent and depreciation costs from land use and other farm assets including little materials and storage system used (₦)

L = Total cost of labour including land clearing, ploughing, harrowing, heaping, weeding, fertilizer and chemicals application and harvesting (₦)

K= Total capital cost including cost on fertilizers, pesticides, herbicides, fungicides and input / output transportation costs (₦)

B1, B2, B3 are rent, labour and capital elasticity of production respectively.

Determinants of Farmer's Technical Efficiency

The inefficiency model is specified as follows:

$$EFF_i = \delta_0 + \sum \delta_s S + \delta_f FD + \delta_r R + \delta_d D + e_i$$

EFF = Technical Efficiency score

S = Vector of socio-economic factors (farmer's sex, experience, farm size, level of involvement in farming, extension contact, access to credit, land allocation to tubers, rate of fertilizer application).

FD= Farm distance (km)

R = Farmer's place of residence (0 if village residence; 1, if farmstead)

D = Agricultural Diversification level (index)

δ_0 =*Constant*

δ_s =*vector of socio-economic parameters*

δ_f = *farm distance parameter*

$\delta_{r=}$ *residence parameter*

δ_d =*Agricultural diversification parameter*

ei =error term reflecting omitted variables

Model Specification

INEFF = $\delta_{0\,+}\ \delta_1 X_1 + \ldots + \delta_n X_n$

$\delta_{0\,=}$ *constant*

X_1 = farmer's sex (1, if male; 0, if female)

X_2 = Farmer's experience (years)

X_3 = Level of involvement in farming (0, if part-time; 1, if full-time)

X_4 = Extension contact (1, if extension contact; 0, if not)

X_5 = credit usage; (1, if credit is taken for farming; 0, if not)

X_6 = Farm size (acres)

X_7 = rate of total farmland allocated to tubers

X_8 =Fertiliser usage (1, if Yes ; 0, if No)

X_9 = Farm distance (km)

X_{10} = Farmer's residence during farming (0, if village; 1, if farmstead).

X_{11} = Level of agricultural diversification (index to be generated)

A Priori Expectations

It is expected that TE increases with the farm size, farmer's residence choice, access to credit, fertilizer usage and extension services, agricultural diversification, land allocation to tubers, farmer's experience, and level of involvement; but it should decrease with farm distance and farmer's sex.

Measuring Agricultural Diversification Index

Agricultural diversification is the combination of crops and land diversification (Alpizar, 2007). Diversification is one of the strategies used by farmers to minimize risk on the farm. But how this affects farmer's technical efficiency, makes the analysis worthwhile. Diversification, as the opposite of specialization, implies a number of enterprises and their relative share in the enterprises' combination. The literature proposes different methods for measuring enterprise diversification (Lecaillon, 1988), which could be adjusted and adopted to measure agricultural diversification. In this study, we measure the Agricultural Diversification Index of farmers using the following formula:

$$D(i) = Ln[P_i*N_i* \Pi x_{ij}]$$

$$D(i) = Ln[P_i*N_i* \Pi[s_{ij}/S_i)] \quad i= 1\ldots n; j =1 .. m$$

Where,

$D(i)$ = Diversification index (or D-index) of farmer i;

Pi= number of plots making the farm size adopted by farmer i;

Ni = number of crop enterprises cultivated by farmer i on the plots;

x(ij) = share of the crop enterprise j adopted by farmer i ;

s(ij) = farm size to enterprise j adopted by farmer i;

S_i = total farm size adopted by farmer i;

Π = product sign for multiplying crop enterprises shares.

Ln = natural log sign for diversification index

RESULTS AND DISCUSSIONS

The farmer's socio-economic characteristics are summarized in Table 1. Ninety five percent of the respondents were male, against only 5 percent of female. Sixty–eight (68) percent of food farmers were full-time farmers, against 32 percent that were part-time farmers. The average year of experience was 26 years. About 70 percent of the respondents claimed having at least one extension contact, against 30 percent who had not. Farmers cultivated an average of 14.61 acres. The average farm distance was 5.98

km and about 74 percent of farmers resided in the village during farming, as against 26 percent who decided to reside on the farm location. In terms of diversification, the average agricultural diversification index was 9.25 and farmers cultivated an average of crops combination ranging from tubers (yam, cassava), cereals (maize, sorghum, rice), legumes (cowpea, groundnut, soya bean), and vegetables (pepper, tomatoes, melon, water leaves, tobacco, etc). An average of 41 percent of the farm was on tubers (yams and cassava). Sixty–five (65) percent of farmers used fertilizers, against 35 percent who did not. Forty–three (43) percent of the respondents had access to credit, against 57 percent who had not.

Agricultural Diversification Index

Farmers' crop diversification index (D-index) showed a relatively uniform pattern. The D-index varied between 4 and 8 for 47 percent of the farmers; 8 to 12 for 44 percent; and 12 to 15 for the remaining 9 percent of farmers. This indicates a relatively stable agricultural diversification pattern among farmers in the area (coefficient of variation = 0.02 only).

Analysis of Farmer's Technical Efficiency (TE)

Table 2 shows that food farmers' TE varied from 0.20 to 0.94 betwen with a mean of 0.73. This implies that farmers' agricultural productivity is at an average of 27 percent below the stochastic production frontier.

The Maximum Likelihood Estimation results (presented in Table A, in the Appendix) shows an LR test (λ_c = 10.65) < (λ_t = 12.6) at 6 degrees of freedom (H_0) that the Cobb Douglas to an appropriate functional form fitting the data could not be rejected. Also the the rejected hypotheses H_0: $\gamma= 0$ and $\delta_i =0$ confirm the existence of technical inefficiency and, therefore, significant socio-economic effects among food farmers in the area.

In comparison with other empirical studies, the mean TE index obtained is lower than the 82 percent recorded by Ajibefun, Battese, and Daramola (1996) among small croppers in Nigeria; 79 percent of Amaza and Ogundari (2008) among soybean farmers in the Guinea savannas in Nigeria and the 89 percent obtained by Nchare (2007) in Cameroun among the Arabica coffee farmers.

The Technical Efficiencies Index (TEI) distribution (Table 2) shows that 10 percent of food farmers had a TEI between 0.2 and 0.50, 40 percent had TEI between 0.51and 0.75, while 50 percent had TE scores above 0.75. It could be said that food farmer's productive efficiency to be similar to those farmers on other crops and presents a usual distribution pattern recorded in other parts of the world since labor and capital inputs made positive contribution to output and are utilized efficiently (within the economic zone of production) by food farmers in general. Therefore, other socio-economic factors with inefficiency effects could be researched so as to improve on food farmers' efficiency level.

Determinants of Farmers' Technical Efficiency (TE)

Results from Table 3 show that farmer's sex, experience, extension contact, use of credit, fertilizer usage, rate of lands planted to tubers (yam and cassava), farm distance to village, and farmer's place of residence during farming significantly affected farmers' TE, while farm size, level of involvement into farming (full/part time), and agricultural diversification had no effect on food farmers' technical efficiency.

A coefficient of -0.75 means that female food farmers were technically more efficient than their counterpart male farmers, since the dummy 0 for female 1 for male was adopted.

Farmer's experience, the extension contact, the access to credit, the more land to tubers, and the more distant the farmlands positively influenced farmer's technical efficiency with a coefficient each of 0.002, 0.036, 0.060, 0.147, 0.0058, respectively. Residing on a farm against a village also improves TE in food farming. But TE decreases with the level of fertilizer usage, meaning this technology may not be a good factor for productivity in the area despite the high proportion of users. Would fertilizers be in conflict with local environmental conditions or would it simply be due to an overuse by farmers?

Therefore, farming on distant lands from the village and the strategy of residing on the farm during the production period improves food farmer's productivity. It is the same for access to credit and extension services. The search for fertile lands could be said to be the origin of farm distance; therefore, the benefit derived and the strategies used by farmers could be said to overwhelm the expected negative impact of distance on farm productivity, explaining why the farthest farm location is from farmer's village of residence the more productive the farmer is. This is also confirmed by the non-significance of farm size more available on distant locations. As expected, residing on the farm improves the farmer's TE. This is an indication that farmers had more time for farm maintenance when adopting such a strategic location. This also sees soil fertility to be paramount to farm size. The non-significant effect of diversification on TE would mean that farmers practice uniform level of diversification with no meaningful differences among farmers in the area. It is the most prominent available and used strategy of risk management in this area.

The results indicate that policies that increase farmers' access to credit and extension services are immensely beneficial to farmer's productivity, especially when theses policies are geared towards women farmers.

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

The result from the study suggests to policy makers that farm distance and the residence of farmers during farming are important factors of agricultural productivity among food farmers in the tropics. The use of traditional crops, such as yam and cassava, are also major sources of productivity to farmers in the area. The constant search for fertile soil leading to an extensive system of production was the major source of farmlands on distant locations. This, therefore, calls for a need to providing friendly soil fertility management techniques to enhance food farmer's productivity and limiting the degrading effects of the traditional extensive system of farming, especially at a time fertilizer usage is even showing a negative effect on farmer's productivity. The current practice of diversification if coupled with intensive methods of cultivation would ensure land resources conservation for agricultural sustainability. This calls for research on fertility and labor saving technologies. Supporting policies of credit and extension services towards women would also significantly improve agricultural productivity in the area without compromising long term sustainability; as well informed farmers would understand easily the need for better management of farm resources.

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Table1: Description of the Respondents' Socio-economic Characteristics

Variables	Unit	Mean	Standard
Male	-	0.95	-
Female	-	0.05	-
Full-time	-	0.68	-
Part- time	-	0.32	-
Experience	Year	25.80	11.32
Access to Credit	-	43	-
No access to credit	-	57	-
Extension contact	-	0.70	-
No extension contact	-	0.30	-
Farm size	Acre	14.61	-
Farm distance	Km	5.98	-
Farm Residence	-	0.26	-
Village Residence	-	0.74	-
Land rate to tubers	-	0.41	1.03
Diversification index	-	9.25	0.19
Use of fertilizer	-	0.65	
Non use of fertilizer	-	0.35	

Source: Survey Data, 2006

Table 2: Analysis of the Respondents' Technical Efficiency (TE)

Efficiency range	Frequency	Percentage
0.20 – 0.50	24	10
0.51 – 0.75	96	40
0.76 – 0.85	72	30
0.86 – 1.00	48	20
Total	240	100
TE : $\mu = 0.73$ $\sigma = 0.15$ Min = 0.28 Max = 0.94		

Source: Survey Data, 2006

Table 3: Determinants of Food Farmers' Technical Inefficiency (TE)

Variables	Parameter	Coefficients	Standard Error	t-ratio
Constant	δ_0	0.548***	0.093	5.913
Farmer's sex	δ_1	-0.075*	0.044	-1.703
Farmer's Experience	δ_2	0.002**	0.001	2.12
Extension contact	δ_3	0.036*	0.020	1.69
Use of credit	δ_4	0.060***	0.020	3.0
Fertiliser usage	δ_5	-0.062***	0.021	-2.94
Farm size	δ_6	0.00067^{NS}	0.001	0.67
Land rate to tubers	δ_7	0.147**	0.057	2.57
Farm distance	δ_8	0.0058**	0.003	2.036
Farmer's residence	δ_9	0.028*	0.016	1.70
level of involve ment into farming	δ_{10}	-0.027^{NS}	0.026	1.113
Agricultural diversification	δ_{11}	0.005^{NS}	0.006	0.813

*** ; **; *: coefficient significant at 1%, 5% and 10 % respectively.

NS = not - significant

Source: Survey Data Analysis, 2006

APPENDIX

Table A: MLE Estimates of TE using the Cobb-Douglas Production Function (Ln Output as dependent variable)

Independent variables	Coefficients	Standard Error	t-ratio
B_0 = constant term	1.89	0.29	6.4***
B_1 = Ln Rent/Depreciation	0.030	0.068	0.44^{NS}
B_2 = Ln Labour	0.23	0.074	3.1**
B_3 = Ln Capital	0.78	0.041	19.1***
$\sigma^2 = \sigma_\mu^2 + \sigma_v^2$	0.23	0.032	7.3***
$\gamma = \sigma_\mu^2 / \sigma^2$	0.89	0.42	2.11**

Number of observations = 230; Number of iterations = 9 Mean TE = 0.73
Log Likelihood = -56.09 Returns to Scale = 1.04
LR test (one-sided error) = 10.65
Critical value of λ = 12.6 at 6 D.F.
H_0 accepted

***; **; *: level of significance at 1, 5 and 10 % respectively NS: not significant

Source: Survey Data Analysis, 2006