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Land Fragmentation And Total Factor Productivity In Arable Crop Production In Ekiti State, Nigeria.

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Abstract
This study evaluated the relationship between land fragmentation and total factor productivity in arable crop farming among small scale farmers in Ekiti State, Nigeria. A three-stage random sampling procedure was used to select one hundred and twenty respondents for the study. Data were collected with the aid of a pre - tested structured questionnaire. Data were analyzed with Descriptive statistics, Simpson index, Tornqvist index, and multiple regression analysis. The result of the descriptive statistics indicated that the average age of the respondents was about 44 years with an average farming experience of about 14 years. The average years spent in acquiring formal education was about 9 years while the average household size of 4 was recorded, 42 per cent of the respondents readily have access to labour and their average farm size was 0.96ha, 22 per cent of the sampled farmers have access to motorable road facility. About 54 per cent of the sampled farmers took credit facility. The average number of extension visit received by the farmers in the last one year is 3 and the average monthly off farm income recorded by the farmers was ₦47,486:00. Also, the average number of plots per household is about 4 while the average plot size recorded in the study area was 0.41ha. . Also, the average distance of plots from the respondents' houses is 1.02km. The result of the Simpson index shows that the mean fragmentation index of the respondents is 0.78 indicating that the respondents have low fragmented farmlands. Result of Tornqvist index shows that the average Total Factor Productivity recorded was 0.88. The result of the multiple regression analysis shows that the coefficient of fragmentation index and age were significant and both have negative relationship with total factor productivity among the arable crop farmers in the study area. This suggests that, as the number of separate parcel of lands operated by the arable crop farmers' increases the total factor productivity will be decreasing. However, the coefficients of farmers' household sizes, total farm size, motorable road, extension services, and credit use were all positively significant.
The study concluded that, while land fragmentation might provide farmers with short-term survival strategies by diversifying their risks, it has has a detrimental effects on Total Factor Productivity through resource use efficiency.

Keywords: *Land Fragmentation, Total Factor Productivity, Small-Scale Farmers, Simpson Index, and Tornqvist Index*

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I. Introduction

Land and agriculture has continued to play the leading role in global socio-economic activities, political life and in meeting the daily needs of majority of the people around the world (Atieno, 1999). No doubt, Land as an essential natural resource is very important for the survival and prosperity of humanity, as well as for the maintenance of global ecosystems (Rahman and Rahman, 2008). Majority of the rural poor worldwide depend on land cultivation for their livelihoods and necessities of life. Therefore, development policies are often targeted towards ensuring agricultural growth particularly in low-income agrarian developing countries.

Nigeria is a country well-endowed with agricultural resources. The country has a vast arable land area (about 82 million hectares), favourable weather conditions and abundant human resources. Unfortunately, the country has not been able to translate her huge agricultural potentials into reality for the necessary economic gains. A major challenge in transforming the agricultural sector of the country is the domination of the sector by smallholder farmers who operate several small-scattered farms (CGAP, 2017). Agricultural holdings in the country are typically small with average farm size per farming household of about 1.8ha. The small size and scattered nature of the farms is associated with the phenomenon of land fragmentation, which can logically be traced to the customary land inheritance system of the people. The farm-level efficiency of these smallholders

has important implications for the agricultural development of the nation. Efficient farmers make better use of existing resources and produce their output at the lowest cost (Amaze and Manrice, 2005, Sunday et al., 2014). An increase in efficiency in crop production could present a ray of hope and could lead to an improvement in the farmers' welfare and consequently a reduction in their poverty level and food insecurity. In general, analysis of efficiency is associated with the possibility of farms producing a certain optimal level of output from a given bundle of resources or certain level of output at least cost. Productive efficiency is a measure of productivity that assesses output by unit of total input. It is the translation of production technical efficiency into monetary costs. Productivity is considered an economic concept because productivity measures the amount of output produced from an existing resource base. It can also constitute a good measure of sustainability since it is a measure of a performance. Productivity in an economic entity such as agricultural holdings can be defined as the ratio of outputs to inputs; in which a larger value of this ratio are associated with better performance (Global Strategy, 2018). As productivity meets the potential yield, and poverty level is reduced largely, the percentage of employment generation will increase, food security will be guaranteed, there will be growth in the agricultural sector, basic infrastructures in rural areas will result in rural development of the farm settlements. Increases in agricultural productivity lead also to agricultural growth and can help to alleviate poverty in poor and developing countries, where agriculture often employs the greatest portion of the population (OECD, 2006). Productivity improvements particularly in developing countries have been found to be a powerful force in poverty reduction (De Janvry and Sadoulet, 2002). Higher productivity can be expected to lower food prices either at national or global level. Agricultural productivity is a subject of interest for policy-makers and analysts because, through increased productivity, farms can better allocate scarce resources to other pursuits. Therefore, improving productivity in agriculture is indispensable for economic development of any agrarian economy. There are two principal options in measuring productivity these are; (i) Partial Factor Productivity (PFP) and (ii) Total Factor Productivity (TFP) (OECD 2001). While PFP is a ratio between output and a specific factor input (capital or labour), TFP is defined as the ratio of an index of aggregate output to an index of aggregate input. It relates to productivity counted by a ratio of output produced and an index of composite inputs. TFP is often describe as the weighted average capacity of all inputs, which can be determined by gross output or value added (Owyong 2000). Hence, the principal aim of this study is to produce empirical information concerning land fragmentation and its effects on total factor productivity among smallholders' arable crop farmers in the study area.

Total Farm Productivity (TFP) relates to productivity counted by a ratio of output produced and an index of composite inputs. In other words, TFP is the weighted average capacity of all inputs (Owyong 2000). The output can be determined by gross output or value added. However,

II. Literature Review

Land Ownership affects effective land use, farming systems, institutional structures, ecological conditions, adoption and use of technology, food production and self-sufficiency, coupled with overall wellbeing of the rural and urban population (Idris, 2006). From the foregoing, it is obvious that land use limitations do influence the rational use of agricultural land. One of the major land use limitations identified by researchers is land fragmentation. Bizimana, Nieuwoudt, and Ferrer (2004) defined land fragmentation as a situation whereby farmers are operating two or more geographically separated tracts of land, taking account of the distances between those parcels. Also according to Wu, Liu, and Davis, (2005) Land fragmentation is a phenomenon that exists when a household operates a number of owned or rented non-contiguous plots at the same time. Van Dijk (2003; 2004) identified four categories land fragmentation as follows; fragmentation of land ownership; fragmentation of land use; internal fragmentation, and separation of ownership and use. Fragmentation of land ownership refers to the number of landowners who use a given piece of land while fragmentation of land use refers to the number of users that are also tenants of the land. Internal fragmentation emphasizes the number of parcels exploited by each user and considers parcel size, shape and distance as the main issues. Separation of ownership and use involves the situation where there is a discrepancy between ownership and use.

Scholars and researchers differ greatly with respect to benefits and costs of land fragmentation (Sklenicka, 2016; Sklenicka et al., 2014). Nevertheless, the general notion is that, the existence of fragmented landholdings is regarded as an important feature of less developed agricultural systems. A school of thought sees land fragmentation as the source of ineffective agriculture (Sklenicka et al., 2014; Apata et al., 2014; Latruffe and Piet, 2014; Corral et al., 2011; Di Falco et al., 2010; Rahman and Rahman, 2008; Van Hung et al., 2007;). This school of thought considers land fragmentation as a major threat to efficient production system because continuous subdivision of farms would lead to small sized land holdings that may be hard to economically operate. According to this viewpoint, land fragmentation is harmful to productivity in a number of ways: fragmented land holdings can increase transport costs. If the plots are located far from home, and far from each other, there is a waste of time for the workers spent on travelling in between the plots and home. Land

fragmentation might also increase the risk of disputes between neighbours (Mwebaza and Gaynor, 2002). Also, Shuhao (2005) opined that the costs associated with land fragmentation are principally seen in terms of inefficient resource allocation especially labour and capital, and the resulting cost increase in agricultural production. Fragmentation, leads to scattering of plots, little incentive for improvements, lack of security of tenure, and restricted scale of operations. However, Kakwagh, Aderonmu and Ikwuba (2011) stated that fragmentation according to some researchers allows farmers with scattered plots to benefit from risk management through the use of multiple eco-zones and the practice of crop scheduling. It also enables farmers to disperse and reduce risk by a variety of soils and other micro-climatic and micro-environmental variations. Also land fragmentation makes it possible for farmers to grow a variety of crops that mature and ripen at different times; so that they can concentrate their labour on different plots at different times thereby avoiding household labour bottlenecks. Therefore, according to Alemu, Ayele, and Berhanu (2017) the advantages and disadvantages of land fragmentation depend entirely upon the local economic and natural environment. Small fragmented land holdings might also cause difficulties to grow certain crops, and prevent farmers from changing to high profit crops. More profitable crops, like for example fruit crops, require larger plot areas, so if the farmers only possess small and fragmented plots they may be forced to grow only less profitable crops (The World Bank, 2005). Land fragmentation hinders economies of scale and farm mechanization. Small and scattered plots hamper the use of machinery and other large-scale agricultural practices (Kadigi, 2017). In small fields operating machines and moving them from one field to another can cause problems. Small land holdings might also discourage the development of infrastructure like transportation, communication, irrigation, and drainage (Mwebaza and Gaynor, 2002).

III. Methodology

Study Area

The study was carried out in Ekiti State, Nigeria. The state lies in the Southwest geopolitical zone of the country and share boundary with Kwara State in the North, Kogi state in the East, in the West with Osun State and Ondo State in the South. Ekiti State is located between longitudes 4º 45' to 5º 45' E and latitudes 7º15' to 8º5' N. The state enjoys a typical tropical climate with two district seasons, the rainy season, which is from March to October with a peak of 1800mm, and the dry season that lasts from November to March. According to the Nigerian population census of 2006, the state has a population of 2,210,957 with a total land area of 6,353km^2 and a population density of about 350 people/km^2 (NPC, 2006). Ekiti State is generally an agrarian state with tropical forest existing in the Southern part and Guinea Savannah in the Northern part of the State. Majority of the indigenous inhabitants are practicing small-scale farmers. Farmers in the state are engaged in production various agricultural produce such as arable crops like, maize, rice, yam, cassava, plantain and cash crops such cocoa, and kolanut a sizable population is also involved in livestock production.

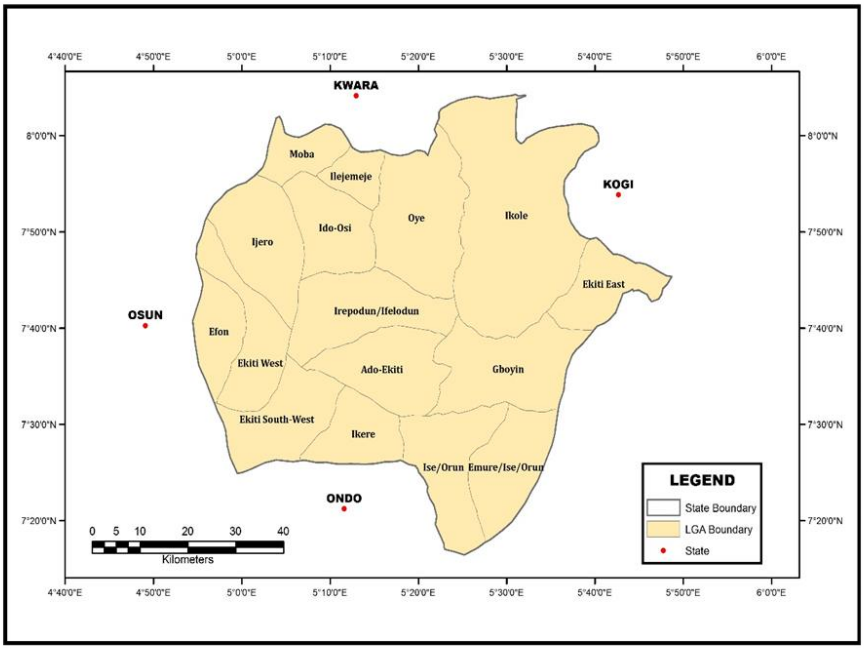

Fig I: The Study Area

Sampling Procedure and Data Collection

A three-stage simple random sampling technique was used in selecting the respondents for this study. First, six Local Government Area (LGAs) was selected; this was followed by the selection of two towns/villages from each of the selected local LGAs. Finally, ten respondents (arable crop farmers) were then selected from each of the selected towns/villages. In all one hundred and twenty respondents were selected for the study. Data were collected with the aid of a pre - tested structured questionnaire. Information were collected on the respondents' socio-economic characteristics such as age, gender, marital status, educational level, household size, etc, farm characteristics, mode of land acquisition, sizes and number of farms, location of farms, distance between farms and farmers institutional characteristics.

IV. Analytical Techniques

Measuring Land Fragmentation

According to Bentley, (1987) there are six different parameters generally used to measure the degree of land fragmentation: farm size, number of plots, plot size, plot shape, spatial distribution of plots, and the size distribution of the plots. Although the common measurement of fragmentation used in studies is an average of the number of plots per farm, many authors use an index of fragmentation to standardize measures of fragmentation authors also use. Therefore, following the study of Kadigi et al, (2017) this study also employed the Simpson index. Simpson index is widely preferred because it is sensitive to both size of parcels and number of parcels. The Simpson index can arithmetically be defined as follows:

$$SI = 1 - \frac{\sum_{i=1}^{N} a_i^2}{\left(\sum_{i=1}^{N} a_i\right)^2} \quad \text{.....1}$$

where a_i is the value of a product i that a household produces, and N is the number of products. Likewise, for land fragmentation, a_i is the area of plot i and N is the total number of plots. The value of the index varies between zero and one, with a larger value indicating greater land fragmentation. A value of zero indicates complete land consolidation (one parcel only), while the value of one is approached by holdings of numerous parcels of equal size. We use the land fragmentation index together with other control variables in a regression model to investigate their relationship with TFP

Measuring Total Farm Productivity

Following the works of Abdul-Qadir, Okoruwa, and Olajide (2016), Tornqvist TFP model was adopted in this study. The Tornqvist index of TFP is commonly used for computing the total output, total input and TFP indices by commodity/farm system/sector, etc. under different locations (Praduman, Surabhi and Hossain 2008). The model was estimated by dividing the value of output by the value of the variable inputs used in production.

Total Factors Productivity (TFP): $$TFP = \frac{Q_i}{\sum_{i}^{n} X_i} \text{.....2}$$

Q_i is value of ith farmer total output measured in Naira
X_i are the variable inputs.
X_1 = labour cost in (N)
X_2 = Cost of Planting material in (N)
X_3 = Cost of pesticides used in (N)
X_4 = Cost of fertilizer used in (N)
X_5 = Cost of herbicides used in (N)

Total Fixed Cost (TFC) was ignored because this does not affect both the profit maximization and the resource-use efficiency conditions. Besides, it is fixed and as such a constant. In addition, all outputs and inputs were normalized by conversion to per hectare per year.

A multiple regression analysis was used to determine the effect of land fragmentation on total factor productivity among arable crop farmers in the study area. Since economic theory does not specify a particular function relating effects of land fragmentation on total factor productivity four different functional forms namely: linear, exponential, double log and semi-log functions were fitted. Then, the lead function was chosen based on economic and econometric criteria.

The model is implicitly specified as follows:
TFP = f (FID, AGE, FEXP, EDUC, HHZ, AVLAB, TFSZ, ACRD, CRDU, NEXT, OFFI)
TFP = Total Factor Productivity of individual farm
FID = Fragmentation index
AGE = Age (years)
FEXP = farming experience (years)
EDUC = Educational attainment (years)
HHZ =Household size (Numbers of people living with the respondents)
AVLAB=Availability of Labour (Yes=1, No =0)
TFSZ = Total Farm size (ha)
ACRD=Accessible road (Yes=1, No=0)
CUSE = credit usage; (1, if cred it is taken for farming; 0, if not)
NEXT = Number of extension visit (number)
OFFI = Off farm income (Naira/month)

V. Results And Discussion

Socio Economic Characteristics of the Respondents

The result of the socio-economics distribution of the respondents is as presented in Table 1. From the table, the average age of the respondents was 43.9 years with minimum and maximum age of 22 years and 68 years respectively. Average farming experience was 14.2 years with a minimum and maximum farming experience of 2 and 41 years respectively. The average years spent in acquiring formal education of 9.22 years with average household size of 4. A minimum household size of 1 and maximum household size of 8 was recorded. About 42 per cent of the respondents readily have access to labour, while the average farm size was 0.96ha with a minimum and maximum farm size of 0.50ha and 4ha relatively. This clearly shows that the farmers are basically smallholders. Just about 22 per cent of the sampled farmers have access to motorable road facility. About 54 per cent of the sampled farmers took credit facility for their farming activities, this is an indication that credit facilities are not readily available for the farmers. It then means that the farmers will have to look for other means such as personal savings, family and friends for source of finance for their farming activities. The average number of extension visit received by the farmers in the last one year is 3. However, the maximum number of visit received was 4 while some farmers did not receive any extension visit in the past one year. The average monthly off farm income recorded by the farmers was ₦47,486:00 with minimum and maximum recorded off farm income of ₦25000 and ₦95000 respectively.

Table 1: Socio Economic Characteristics of the Respondents

Variable	Mean	Std. Dev.	Minimum	Maximum
AGE	43.9	9.1	22.00	68.00
FEXP	14.2	5.87	2.00	41.00
EDUC	9.22	2.31	0.00	15.00
HHZ	4.00	1.27	1.00	8.00
AVLAB	0.42	0.13	0.00	1.00
TFSZ	0.96	1.51	0.50	4.00
ACRD	0.22	0.08	0.00	1.00
CUSE	0.54	0.11	0.00	1.00
NEXT	3.00	1.10	0.00	4.00
OFFI	47486	9058	25000.00	95000.00

Source: Field Survey Data, 2023

Land Fragmentation Characteristics

Table 2 shows the result of land fragmentation characteristics in the study area. From the Table, average number of plots per household is about 4 while minimum and maximum number of plots per household is one and seven respectively. The average plot size recorded in the study area is 0.41ha, while the minimum and maximum plot size is 0.12ha and 3.82 ha respectively. Also, the average distance of plots from the respondents' houses is 1.02km, the minimum and maximum distances recorded is 0.50km and 7.00km respectively.

Table 2: Land Fragmentation Characteristics

Land Fragmentation Characteristics	Mean	Std. Dev.	Min	Max
Number of plots per household	3.86	1.07	1.00	7.00
Average plot size (ha)	0.41	0.34	0.12	3.82
Average distance of plots from the farmer's house (km)	1.02	3.21	0.50	7.00

Source: Source: Computed from Field Data, 2023

Degree of land fragmentation

This section deal with the classification of respondents according to degree of land fragmentation as estimated using the Simpson land fragmentation index. According to Simpson land fragmentation index values tending towards 0 indicate a high degree of fragmentation and vice versa. From the table, 11.67% of the respondent have fragmentation value of less than 4 and are therefore categorized as cultivating high fragmented farmlands, 21.67% had a fragmented index of between 0.41 and 0.60, this group were categorized as having moderately fragmented farmlands. The remaining 66.67% have fragmentation index of above 0.60 and are thus classify as having low fragmented farmland. The mean fragmentation index of the respondents is 0.78 indicating that the respondents have low fragmented farmlands. This is an indication that majority of the respondent in the study area are operating consolidated farmlands.

Table 3: classification of respondents by degree of Fragmentation of land use

Fragmentation Index	Frequency	Percentage	Classification
≤ 0.4	14	11.67	High
0.41- 0.60	26	21.67	Moderate
0.61 – 0.80	44	36.67	Fairly low
>0.80	36	30.00	Low
Mean	0.78		
Standard Deviation	0.27		

Source: Computed from Field Data, 2023

Total factor Productivity

Total Factor Productivity (TFP) is a measure of how productive or efficient a business or economy is. It quantifies the relationship between output and inputs. TFP index was generated for individual farms and the frequency distribution is as presented in table 4. The average TFP recorded is 0.88. The TFP value of 0.88 indicates that the farm is operating at 88% efficiency in terms of utilizing its input resources to produce output. In other words, there is room for improvement in productivity.

Table 4 Frequency Distribution of Total Factor Productivity

Range of TFP	Frequency	Percentage
≤ 0.85	53	42.50
0.86 – 0.90	33	26.67
0.91 – 0.95	24	19.17
0.96 – 1.00	10	7.50
Mean	0.88	
SD	0.92	
Minimum	0.74	
Maximum	0.98	

Source: Computed from Field Data, 2023

Effect of land fragmentation of total productivity

The result of multiple regression analysis used evaluation the relationship between land fragmentation and total factor productivity among arable crop farmers in the study area is as presented in Table 5. The double-log function was chosen as the lead equation. The choice of this function was based on the value of the coefficient of multiple determination (R^2) and number of significant variables and the signs of the coefficients of the regression in line with *a priori* expectation. The coefficient of multiple determination (R^2) was 0.716, indicating that the independent variables in the model explained 71.6% of the total variation in the contribution of the women to household expenditure. The result shows that seven variables were significant in determining total factor productivity among the arable crop farmers in the study area. The variables were fragmentation index, age, household size, total farm size, accessible road, number of extension visits, and credit usage. The fragmentation index and age were significant and both have negative relationship with total factor productivity among the arable crop farmers in the study area. This suggests that, as the fragmentation indices increases that is increase in number of separate parcel of lands operated by the arable crop farmers the total factor productivity will be decreasing. This is logical because fragmented landholdings can lead to inefficiencies due to increased

travel time between plots, higher transportation costs for inputs and outputs . Also as farmers age increases they may face declines in physical stamina and becomes more risk averse, all these will contribute to decline in total factor productivity.

Table 5: Effect of Land Fragmentation on Total Factor Productivity

	Linear	p-value	+ Double log	p-value	Semi log	p-value	Exp	p value
FID	-0.177***	0.002	-0.049**	0.037	-0.071*	0.061	-0.068**	0.098
AGE	-0.409**	0.018	-0.518**	0.016	-0.402**	0.021	-0.344 ***	0.002
FEXP	0.180***	0.006	0.737	0.332	2.609 **	0.053	1.012	0.115
EDUC	0.108**	0.032	0.106	0.161	0.164**	0.039	0.037**	0.045
HHZ	0.690*	0.081	0.048**	0.025	0.851	0.351	1.242***	0.062
AVLAB	5.767	0.172	9.771	0.551	8.476	0.117	8.111**	0.039
TFSIZE	2.478	0.113	2.675*	0.082	8.891	0.331	1.605	0.103
ACRD	0.193	0.137	0.022**	0.045	0.183	0.271	0.253**	0.028
NEXT	1.051	0.161	0.013**	0.012	0.203	0.113	0.133	0.222
CUSE	0.226*	0.052	0.428**	0.014	0.540	0.218	0.110	0.310
CONST	3.451	0.112	0.253	0.095	4.083	0.019	5.465	0.215
R^2	0.405		0.716		0.414		0.383	
Adj R^2	0.289		0.624		0.232		0.152	

Note: *** Significant at 1%, ** Significant at 5%, * Significant at 10%. Values in brackets are t-ratios; + Lead equation

Source: Data Analysis, 2023

Farmers' household sizes were positively significant, meaning that larger household sizes will boost total factor output. This is feasible since larger families frequently imply more family members are available to work on the farm, which can improve labour availability and thus raise production. More people on deck allows for work division and specialization, resulting in more efficient agricultural operations. Equally, the coefficient of total farm size was positively significant showing that with increase in total farm size, total factor productivity will increase. Farm size and production are strongly associated because larger farms benefit from economies of scale. They can employ labor, capital, and technology more effectively than smaller farms. According to studies, farmers with greater farm holdings can achieve higher production since they can invest more in modern inputs and technology (Pingali 2012). In contrast, small farm sizes may impede the adoption of new technology, lowering total production.

A positive significant value was recorded for the coefficient of access to motorable road. Infrastructure particularly adequate roads, is critical to increasing TFP among smallholder farmers. Access to roads lowers transportation costs, allows for better access to input markets, and improves the potential to sell output in more profitable markets. This immediately improves farmer profitability and productivity by extending market opportunities and lowering post-harvest losses. According to Dorosh *et al.,* (2010), road access improves production by lowering transaction costs and increasing access to agricultural inputs and markets. In Nigeria, research shows that poor infrastructure, particularly weak road networks, hinders smallholder farmers' profitability and productivity (Ajani and Igbokwe, 2013). Farmers may minimize transportation costs and losses by increasing road access, resulting in increased market accessibility.

The coefficient of extension services was also significant and positively related with TFP. Extension services offer farmers with valuable technical information, skills, and new technology to help them increase their output. Farmers benefit from frequent extension visits because they learn about current farming techniques, new crop varieties, and best agricultural practices, all of which lead to increased output. According to research, farmers who have access to extension services do better in terms of technical efficiency and production than those who do not. Dercon *et al.* (2009) discovered that extension visits had a substantial beneficial influence on production by providing farmers with important knowledge about new technology and practices. In Nigeria, similar outcomes have been observed, where extension services have assisted to the adoption of improved inputs and techniques, leading to better productivity among smallholder farmers (Aina *et al*., 2010).

The coefficient of credit use also shows significant positive relationship with total factor productivity, this is an indication that with access to credit facilities, total factor productivity will increase. Credit facilities offer small-scale farmers with the financial resources they require to invest in inputs such as seeds, fertilizers, machinery, and irrigation systems, therefore increasing output. According to research, access to financing is an important predictor of TFP among smallholder farmers. Farmers may raise their input utilization and adopt contemporary agricultural methods with enough funding, hence enhancing efficiency and production (Carter, 1988). For example, in Kenya, access to finance has been shown to boost farm output, particularly among smallholder farmers who would otherwise lack the financial resources to invest in required inputs (Kibaara,

2005). The lack of access to institutional loans in emerging economies such as Nigeria severely limits smallholders' capacity to enhance production.

VI. Conclusion

This study was conducted to assess land fragmentation effects on total factor productivity in arable crop production in Ekiti State, Nigeria. The result of the study shows that the average number of plots per household is about 4 while minimum and maximum number of plots, average plot size recorded in the study area is 0.41ha, average distance of plots from the respondents' houses is 1.02km. The mean fragmentation index of the respondents is 0.78 indicating that the respondents have low fragmented farmlands. This is an indication that majority of the respondent in the study area are operating consolidated farmlands. The TFP value of 0.88 indicates that the farm is operating at 88% efficiency in terms of utilizing its input resources to produce output. The fragmentation index and age were significant and both have negative relationship with total factor productivity among the arable crop farmers in the study area. This suggests that, as the fragmentation indices increases that is increase in number of separate parcel of lands operated by the arable crop farmers the total factor productivity will be decreasing. However, the coefficients of farmers' household sizes, total farm size, motorable road, extension services, and credit use were all positively significant meaning that any increase in any of these variables will in increase the total factor productivity of arable crop farmers in the study area.

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