LAND PRODUCTIVITY OF DIFFERENT USE LEVELS OF SUSTAINABLE SOIL MANAGEMENT TECHNIQUES OF ARABLE CROP FARMERS IN IMO STATE, NIGERIA

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Abstract
Land productivity of the farmers can be improved when farmers adopt improved soil management techniques that are environmentally friendly. This study looked at land productivity of different use levels of sustainable soil management techniques (SSMT) of arable crop farmers in Imo state, Nigeria. Multi-stage random sampling technique was used to select 209 arable crop farmers. Objectives of this study were elicited from the sampled respondents through a well-structured questionnaire. Data were analyzed using descriptive statistical tools such as mean, frequency distribution, percentage and partial productivity index model. Results showed that the mean farm size was 1.0 hectare. Majority of the arable crop farmers, 55.0 percent had a high use level of sustainable soil management techniques compared to about 45.0 percent that had a low use level of the sustainable soil management techniques. This classification stems from the mean probability use-level which is 0.47. The result reveals a mean probability use level of SSMT of 0.311 for farmers within the low use category and a mean probability of 0.594 for high use category of SSMT. Therefore, appropriate policies should be channeled towards eradicating challenges faced by the arable crop farmers as this would translate to increased land productivity in the area.

Keywords: Land Productivity; Use Levels; SSMT; Arable Crop Farmers; Imo State

Introduction

Agriculture is the most important economic sector of many developing countriesof which Nigeria is not left out.In 2020, food production is projected for about 9.1 billion people globally and increased to over 10 billion by the end of the century (FAO, 2011). This calls for the transformation of agricultural production systems which will bring about need an increase the productive capacity of the small holder farmers who constitute about 80% of the farming work force (CBN, 2006). However, there is a pertinent question of which technologies and practices are most appropriate to attain this objective considering the population on hand. Intensification of sustainable soil management technologies (SSMT) has received greater attention recently (Tillman et al., 2002; FAO, 2010) which according to them include increased food production without depleting soil and water resources, as well as restoration of soil fertility. IFAD, (2011) noted increased resilience of farming systems to climatic risk, and improving their capacity to sequester carbon and climate change mitigation as some of the benefits of SSMT. In addition, the sustainable use of soil and land in agricultural areas of the world is of increasing significance, particularly in the face of a changing climate. Schaetzl and Anderson, (2006) re-iterated that while management of our soil resource is critical to maintenance of agricultural productivity for significant contribution to the economy, it is also relevant for the livelihood of the rural population. Hence,productivity is an average measure of the efficiency of production. "It is a measure of ratio of output to what is used up (inputs of capital, labour, land, energy, materials etc) in the production process" (Olayide and Heady, 1982). According to Saari (2011), "productivity is the total output per unit input". "It refers to the relative performance of the processes used in transforming given inputs into outputs" (Egli, 2006). Productivity may be examined collectively (across the economy) or viewed industry by industry to investigate the trend in labour growth, wage levels and technological improvement. Farm productivity for instance expresses the ratio of agricultural outputs to agricultural inputs. Individual farm product hasvarying densities and measuring units hence, measuring overall agricultural output is difficult. Output can be measured as the market value of final output, which ignores intermediate products (FAO, 2001).

Ukoha (2000) emphasized the use of high yielding inputs to boost farmers' productivity and income. Total factor productivity can be regarded as a measure of the long term technological change of an economy if high yielding inputs are used (Ayres and Warri, 2002).This force of change has led farmers to the use of variant soil practices that are quite unsustainable. However, unsustainable soil techniques constitute a very serious ecological and environmental problem facing farmers in Imo State (Onweremmadu *et al.* 2008). About 85% of soil deterioration is caused by soil erosion, water and wind leading to low productivity of the soils. Hence, the productivity of soils has become a constant challenge for farmers and agriculturists in the State. In addition, low soil fertility inevitably leads to low agricultural productivity since agricultural development is fundamentally affected by productivity status of soil resources. Poor soil management and fragile nature of rural soils generally account for heavy nutrient losses through soil erosion and leaching.A better understanding the principles bywhich native soils function will assist in the maintenance of a productive and profitable soil for the present and for future generations (Walker *et al.* 2006). Thus, this study set out to examine the land productivity of different use levels of sustainable soil management techniques of arable crop farmers in Imo state, Nigeria which has not been documented.

Materials and Method

This research was conducted in Imo State of Nigeria, which is located in the South-Eastern part of Nigeria with a land area of 5,530 sqkm. The State lies between latitudes $4^0 45^I$N and $7^0 15^I$N and Longitudes $6^0 50^I$E and $7^0 25^I$E. The State shares boundaries with Abia and Cross Rivers State to the East, Delta State to the West, Rivers State to the South and Enugu and Anambra State to the North (ISSYB, 2004). The State has Owerri as its capital and made up of 27 (twenty-seven) Local Government Areas which are grouped into three agricultural zones namely Owerri, Orlu and Okigwe. Farming is the predominant occupation of the rural inhabitants. Multi-stage sampling technique was used for this study. In the first stage, two local government areas (LGAs) were purposively selected from each of the three agricultural zones of the State namely (Owerri, Okigwe and Orlu). The selection of theseLGAs was based on their predominant agricultural activities and use of sustainable soil management techniques (SSMT). The LGAs selected were Ngor-Okpala and Ohaji-Egbema from Owerri zone, Nwangele and Isu from Orlu zone while Isi-ala Mbano and Obowo were selected from Okigwe zone, respectively. A total of six (6) local government areas were used for this study. The second stage involved a random sample selection of arable crop farmers from the list of registered arable crop farmers using SSMT, kept with the zonal ADP's in each of the selected LGAs from the various zones of the State. Owerri zone has 122 registered arable crop farmers while Orlu and Okigwe zones have 130 and 109 arable crop farmers. This shows that there are unequal numbers of arable crop farmers across the three zones; hence an equal representation of sample was made from a proportion of 70 percent of the total population from each zone. This gave a sample size of 85 for Owerri zone, 91 for Orlu zone and 76 for Okigwe zone giving a total of 252 arable crop farmers across the six LGAs. However, the study eventually used only 209 valid questionnaires for analysis. Data were analyzed using descriptive statistical tools such as (mean, frequency distribution, percentage) and partial productivity index model.

The use-levels of sustainable soil management techniques was classified to high and low use using the mean score obtained across the farmers in the area(Ehirim *et al*. 2013). The mean value was estimated as;

$$\bar{X} = \frac{\sum_{i=1}^{n} SSMT\ Use-Level}{n} \quad \text{---- ---} \quad \textbf{eqn.1}$$

Where; any ith farmer's Use-level ≥ X is declared a high use-level of SSMT**,** and low use level, if otherwise and n is the sample size.

Land productivity of different use-level of SSMT in the area was analyzed using partial productivity of land subject to different use-levels of SSMT. The farmers were classified based on their use-level and their corresponding level of land productivity were determined using partial productivity index for land as used by Olayide and Heady (1982) and adapted by Dixon and McDonald (1990). This is expressed as the ratio of output or returns from crop production to the total cost of land and cost of its improvement within a specific period of time.This approach showed the perfomance of the different ith class of lands with different sustainable soil management techniques.

The model is specified as follows;

$$PP_i = \frac{Y_i}{L_i} \quad \text{--- --- ---} \quad \textbf{eqn.2}$$

Where;

PP_i = Partial Productivity Index of Land with ith use-level

Y_i = Quantity of output produced from an ith class of land (Naira)

L_i = Total rent and cost of land improvement of ith class of land(Naira)

Results and Discussion

Farm Size of Arable Crop Farmers in Imo State

The distribution of farmers based on their farm size is shown in Table 1. According to the Table, majority of the farmers, 60.3 percent had farm sizes ranging from 0.01– 1.00 hectares. However, the mean farm size was 1.0 hectares. This implies that majority of the farmers in the area operated on small-scale bases (cultivating less than 2.0 hectares).This supports the findings of Nwaru (2004) who reported that rural farm lands are characterized by small-sized holdings, fragmented and scattered which poses a great threat to land productivity of the farmers and mechanization. Ukoha et *al.* (2010) further stated that rural farmers who cultivate arable crops operate on small scale bases probably due to the land tenure system available to them. However, the mean farm size in the area is typical subsistence farming where a farmer majorly provides for himself and his family

Table 1: Distribution of Farmers based on Farm Size

Farm Size (Ha)	Frequency	Percentage
0.01 – 1.00	126	60.3
1.01 – 2.00	73	34.9
2.01 – 3.00	8	3.8
3.01 – 4.00	2	1.0
Total	**209**	**100**
Mean	**1.0**	

Source: Computed field survey data, 2015

Classification of Use Levels of Sustainable Soil Management Techniques in Imo State

The classification of the use levels of sustainable soil management techniques of arable crop farmer are shown in Table 2. According to this table, majority of the arable crop farmers, 55.0 percent had a high use level of sustainable soil management techniques compared to about 45.0 percent that had a low use level of the sustainable soil management techniques. This classification stems from the mean probability use-level which is 0.47. Any ith farmers use level greater or equal to the mean probability use level is classified as high use level and low use level, if otherwise. Furthermore, the use levels of the sustainable soil management techniques among the arable crop farmers in the area were generally high. This implies that the introduction of the sustainable soil management techniques in the area yielded a positive outcome, probably due to the exposure of these techniques to the farmers by the extension agents assigned to the various zones of the State. Ofuoku *et al.,* (2009) stated that majority of the arable crop farmers tends to adopt sustainable soil management techniques by way of exposing such packages to them and at the same time being encouraged to use them. Consequently, the high use level of the sustainable soil management techniques recorded in the area could be attributed to the informal interaction of the arable crop farmers, coupled with increased participation in agricultural seminars and workshops. This supports the findings from; Owuor *et al., (*2007) and Apata *et al*., (2010) who posited that regular participation in agricultural workshop tends to provide farmers with reliable information on a wide range of agricultural technologies. The frequency of participation in agricultural workshop is very crucial as it guides the farmers on new farm practices which enhances the output and income of the farm households. NAERLS and NFRA (2009) further reported that organized agricultural workshops enables farm households to be better informed with improved agricultural techniques so as to improve on their income level.

Table 2: Classification of the Arable Crop Farmers based on Use Levels of SSMT

Use Levels of SSMT	Frequency	Percentage
High use level (≥ 0.47)	115	55.0
Low use level (< 0.47)	94	45.0
Total	209	100

Source: Field survey data, 2015

Land Productivity of Different Use Levels of Sustainable Soil Management Techniques of Arable Crop Farmers in Imo State

The productivity of land for the different use levels of sustainable soil management techniques are shown in Table 3. The result reveals a mean probability use level of SSMT of 0.311for farmers within the low use levels of SSMT. This implies that farmers within the low use category did not really exploit the SSMT shown to them by the extension agents. This could be probably due to their conservative nature which makes them less receptive to change. This supports the findings from Ekanem *et al*. (2015). It could be further seen in the result that about 3.3 percent of the arable crop farmers with the probability use levels of SSMT of 0.116-0.186 had a mean partial productivity of 50.561±23.561. There was a marginal increase of 5.7 percent of farmers within probability use range of 0.187 to 0.257 whose mean partial productivity increases marginally to 51.179±27.101. Again, a mean partial productivity of 53.001±25.361 was obtained by a majority (17.2 percent) of the farmers, whose probability use levels rangebetween 0.258 to 0.328. In the same way, 13.4 and 5.3 percent of the arable crop farmers had probability use levels of SSMT of 0.329 to 0.399 and 0.400 to 0.470 with a mean partial productivity of 60.330±29.690 and 62.531±27.681, respectively. It could be deduced from this result that despite the low use levels of SSMT among the farmers, increase in the probability of use of these SSMT can lead to a higher productivity of land. This finding collaborates Osuji *et al*., (2012) and Okere (2013), who confirmed that increased use of soil management techniques increases mean partial productivity of lands. Ehirim *et al.* (2013) further reported that suitability of land for cassava production increases marginal value productivity of land. According to him, suitability of land for cassava production could be due to increase in use levels of SSMT on land. It therefore, suggests that land has a higher marginal value if the sustainable soil management practices can be increased. However, the results obtained in this study differ from Dixon and McDonald (1990) and Fakayode et *al*. (2008).

In a similar manner, the result shows that farmers with high use category of SSMT have higher land productivity associated with increased probability of use of SSMT. Though there is a marginal drop in productivity from 65.440 to 64.120 by farmers whose probability use levels are within 0.542 to 0.612 in the area due to other exogenous variables, which exclude land in arable crop production (Todd, 2006; Waikato, 2009). It could be seen from the result that 20.1 percent of the arable crop farmers between probability use levels of SSMT had a mean partial productivity of 65.440±29.670 while 13.9 percent with the probability use levels of 0.613 to 0.683 had a corresponding increase in mean partial productivity of 68.106±26.721. The progressive increase in partial productivity is due to the efficient use of SSMT by the arable crop farmers in the area. Mac-Ewan *et al*. (2011) and Phillip *et al.* (2012) individually posited that SSMT like crop rotation and organic amendment in the soil respectively will not only ensure a balanced ecosystem but increases over time the output per unit area of crop. This suggest that when the probability of use of SSMT increases as shown in the result, there is a marginal increase in productivity implying that the land productivity will increase provided that farmers adhere to the principles of SSMT in the area (Sadoulet, 2001).

The estimated mean probability for high use category of SSMT is 0.594. This implies that farmers in this category demonstrated a very high use level of SSMT relative to others in the area. It could be further deduced from this result that higher category of use of SSMT corresponds with a higher mean value than the lower categories. Majority (55.1 percent) of the farmers falls within this category and have estimated mean productivity of 68.695 which is marginally greater than the mean productivity of 55.520 presented by the lower category of SSMT in the area. The study therefore suggests that increasing use of SSMT will definitely increase the productivity of land in addition to sustainable ecosystem in line with the observations from; Suleman-Usman (2007); and Ehpraim *et al*., (2015).

Table 3: Descriptive Statistics of Land Productivity of Different Use Levels of Sustainable Soil Management Techniques

Classification of Use Levels	Prob. Use level of SSMT	Mean partial productivity	Standard deviation	Frequency	Percentage	Minimum productivity	Maximum productivity
Low use Levels of SSMT	0.116-0.186	50.561	23.561	7	3.3	20.614	60.412
	0.187-0.257	51.179	27.101	12	5.7	22.016	67.341
	0.258-0.328	53.001	25.361	36	17.2	21.904	76.774
	0.329-0.399	60.330	29.690	28	13.4	24.185	118.430
	0.400-0.470	62.531	27.681	11	5.3	20.541	128.591
Mean	**0.311**	**55.520**	**26.679**	**18.8**	**9.0**	**21.852**	**90.309**
Total	**-------**	**277.602**	**133.394**	**94**	**44.9**	**109.26**	**451.548**
High Use Levels of SSMT	0.471-0.541	65.440	29.670	42	20.1	19.660	134.452
	0.542-0612	64.120	31.152	26	12.4	18.674	156.641
	0.613-0.683	68.106	26.721	29	13.9	26.052	197.150
	0.684-0.754	69.781	28.822	14	6.7	30.381	184.104
	0.755-0.825	75.530	27.930	4	2.0	34.520	196.382
Mean	**0.594**	**68.695**	**28.859**	**23**	**11.0**	**25.857**	**173.746**
Total	___	**343.477**	**144.295**	**115**	**55.1**	**129.287**	**868.729**

Source: Field survey data, 2015

Problems Associated with Land Productivity of Arable Crop Farmers using SSMT

Table 4: shows the problems associated with land productivity of arable crop farmers in the area. It could be deduced from the Table that arable crop farmers in the area face vagaries of problems ranging from high cost of farm inputs to inadequate markets. Table shows that 98.6% of the farmers face problem of land scarcity, 97.6%, high cost of farm inputs, 96.7%, inadequate capital, and 94.7%, erosion challenges. Furthermore, 93.8% of the farmers are faced with poor storage facilities, 84.7%, inadequate markets, 68.9%, land fragmentation, 52.2%, pests and diseases, 49.7%, climatic variations, and 48.3%, Poor road networks. Hence, this implies that these problems are responsible for the challenges militating against land productivity of the arable farmers in the area. This further implies that these problems are the reasons farmers engaged in the use of variant soil management techniques which limit the productivity of the land thereby resulting to low income of the farmers. This finding corroborates with the observations of Osuji *et al.*, (2012) and Ehirim *et al.*, (2013). Thus, appropriate policies should be channeled towards eradicating these challenges faced by arable crop farmers in the area as this would translate to increased land productivity of the farmers.

Table 4: Problems Associated with Land Productivity of Arable Crop Farmers using SSMT

Problems	*Frequency	Percentage
High cost of farm inputs	204	97.6
Scarcity of farmlands	206	98.6
Inadequate capital	202	96.7
Poor storage facilities	196	93.8
Land fragmentation	144	68.9
Pests and Diseases	109	52.2
Climatic variations	104	49.7
Poor road network	101	48.3
Erosion challenges	198	94.7
Inadequate markets	177	84.7

Source: Field survey data, 2015 ***Multiple Responses**

Conclusion and Recommendations

The findings of this study reveals that majority of the arable crop farmers, 55.0 percent had a high use level of sustainable soil management techniques compared to about 45.0 percent that had a low use level of the sustainable soil management techniques. This classification stems from the mean probability use-level which is 0.47.Thus, findings showed that increase in the probability use levels of sustainable soil management techniques increases land productivity of the farmers. This implies that the introduction of the sustainable soil management techniques in the area yielded a positive outcome due to the exposure of these techniques to the farmers by the extension agents assigned to the various zones of the State. Findings further indicate that farmers in the area faced vagaries of challenges ranging from high cost of farm inputs to inadequate markets which poses a threat to land productivity of the farmers. Based on the findings, the study recommends that appropriate policies should be properly channeled towards curbing the problems associated with the land productivity of the farmers while intensifying exposure of improved soil management techniques by the extension agents as this will lead to increased productivity of the land in the area.

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