Journal of Integrated Sciences
Volume 3, Issue 1, December 2022
ISSN: 2806-4801

SUSTAINABLE LAND MANAGEMENT FOR SUSTAINABLE AGRICULTURAL PRODUCTIVITY IN OYO STATE, NIGERIA

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ABSTRACT

Sustainable agricultural production has been one of the major concerns of average Nigerian farmers over a long period of time. This study examined sustainable land management (SLM) practices for sustainable agricultural productivity and farmers' sustainability using cross-sectional data and fuzzy logic to compute the composite farm level indicators. Data were collected from one hundred and seventy-six (176) farmers and Cobb Douglass production function, Tobit and fuzzy logic were used for the data analysis. The results revealed that the estimated parameters with Cobb Douglas production functions show that farm size used (r = 0.0572), years of farming experience (r = 0.172), farmers' age (r = 0.240), income (r = 0.187) and farm management experience (r = -0.204) were significant (p<0.01)) respectively with the exception of *source of irrigation (r = 0.048) with a different level of significance (p<0.10); Tobit regression shows that farm size (β= 0.0193, p<0.05), organic manure (β= 0.0347, p<0.10), fertilizer application (β= 0.1707, p<0.01), continuous cropping (β= -0.0494, p<0.05), pesticide application (β= 0.0807, p<0.01), income (β= 0.0094, p<0.05) and mode of cultivation (β= -0.0524, p<0.05) were the significant determinants of (SLM) while the fuzzy results revealed that total sustainable land use index (SLUI) was 0.276 indicating that farming was generally sustainable. Crop rotation (0.0085), use of herbicide (0.0079), land fallowing (0.0089), cover crop (0.0088) and industrial discharges (0.0089) are among contributive indicators which are used un-sustainably. It was therefore recommended, among other recommendations, that better agronomic practices should be encouraged and informal training through extension services should be conducted to educate farmers in order to have a sustainable increase in agricultural production in the study area.*

Keywords: Agroforestry, Land Management, Sustainable Practices, Tobit, Fuzzy Logic, Nigeria.

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1. INTRODUCTION

Over the past years, Nigeria has dealt with very low yields per hectare due to soil and land degradation which has been one of the major problems of agricultural sustainability in the country's agricultural sector. Continuous loss of farmland to land degradation and soil erosion tends to have negative effects on agricultural sustainability and encountering challenges such as declining soil fertility, land degradation, low levels of farm productivity, low farm income, low outputs and food security (MoFA, 2016). An important issue of consideration in relation to SLM and smallholder crop production is the recent increase in herbicide use (Gazali and Awudu, 2020). As part of measures to reduce the drudgery associated with manual land preparation and weeding, many farmers are increasingly employing herbicides (Watkins et al., 2018).

Sustainable land management (SLM) has been defined as 'the adoption of appropriate land management practice that enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources' (FAO, 2009). Therefore, there is the need for an average farmer to operate various farmland management practices in order to enhance sustainable agriculture through soil and land conservation practices. Hence, this raises the research objectives which are to: examine the determinants of crop production; determinants of sustainable land management practiced by farmers, determine the status of sustainable land management practices (SLMP) among agroforestry farmers and analyze the contributive effect of sustainable land management indicators to land sustainability among the agroforestry farmers in the study area.

2. REVIEW OF LITERATURE

Low agricultural productivity and land degradation are severe interrelated problems in the developing world. In Nigeria, land degradation takes a number of forms including depletion of soil nutrients, salinization, agrochemical pollution, soil erosion, vegetative degradation as a result of overgrazing and the cutting of forests for farmland (Eni, 2012). Land in Nigeria, like elsewhere, is faced with several environmental problems especially the ones resulting from human activities such as land destruction through agricultural practices unsuitable to the climate, slope and soil, extinction of animals and plant species through hunting, fishing and disturbance of habitats, prevention of forest regeneration through unplanned deforestation practices (Oyewo, 2018).Various governments in Nigeria have tried several ways and initiated policies and programs aimed at restoring the country's agricultural sector to its pride (Adama,2016).

The prevalent extent of land degradation in Nigeria is alarming, thus the issue of management cannot be taken for granted, given that these resources constitute the productive base for Nigerian agriculture, and the basis of the livelihoods of many rural and urban households (Oyekale, 2012). However, a general understanding among sustainable agricultural farmers is that 'healthy' soil is a key component of farm sustainability, i.e., healthy soil will produce healthy crop plants.

Traditionally, agroforestry farmers have developed different soil conservation and land management practices of their own.

With these practices, they have been able to sustain their production for centuries thus the effects of resource exploitation have become widespread. There has been growing awareness that productive lands are getting scarce, land resources are not unlimited, and that the land already in use needs greater care. As a result of the increase in world population, other non-agricultural activities are competing for land space; hence there is progressive loss of land for food production. It was affirmed that over time, the demand for food and other agricultural products is increasing, requiring more land which is not available since the earth's land area is finite.

2.1 Fuzzy Sets Concepts

According to Sulo and Chelangat (2012) fuzzy sets concept was defined as X being a set and x being a subset of an element of X. A fuzzy subset A and X is defined as: A= (x, υA(x) for all x Ex, where υA is called a membership function and is an application from X in (0, 1). This means the function associates a real number in degree of belonging of X to A. The concept of land management is not sharply defined and multidimensional; thus, fuzzy set concepts can be used in the study of sustainable land management. If A is a fuzzy set, its membership to land management practices can only take the values between 1 and 0. Where, Y(x) = (1), Y (x) = (0) or 0 < Ya (x) < (1), the membership function represents the degree of membership to the fuzzy subset. For the case of multidimensional analysis, increasing order of subjective evaluations can rank qualitative variables. This has been used by various authors such as Hossein *et al.*, (2009), in their research work 'Sustainable rangeland management using fuzzy logic: A case study in Southwest Iran' by (Mir *et al.*, 2022) on the approach to identify limiting factors in assessing land suitability for sustainable land management.

An example is given by values attached to the findings of (Sulo and Chelangat, 2012) in their study, for instance, excellent, extremely good, very good, good, fairly good, average, fairly bad, very bad and worst in form of multidimensional responses. This concept can also be used to solve the problem of sustainable land management practices on smallholder cassava farmers' productivity in Oyo State Nigeria.

3. METHODOLOGY

3.1 The study area

This study was carried out in Oyo State, Nigeria. The State is located in the Southwestern part of the country, Oyo State consists of thirty-three (33) Local Government Areas grouped under four (4) agricultural zones of Oyo State Agricultural Development Program (OYSADEP). The zones are: Ibadan-Ibarapa, Oyo, Saki and Ogbomoso Zones. Oyo State covers a total land area of about 27,249,000 square kilometers with a total population of about 5.6 million (National Population Commission, 2006). As of 2016, the population of Oyo State was estimated at 7,840, 864 million based on demographic estimates released by the National Bureau of Statistics in 2017. It is situated between Latitude 7^{o} N and 19^{o}N and Longitude 2.5^{o}E and 5^{o}E of the meridian. The State is predominantly agrarian, annual mean rainfall is above 1000mm and the rainy season in the State averaged eight months in a year. Rain starts in Oyo State during the first week of March with storms. Mean temperature varies from daily minimum of 18.9^{0}C to a daily maximum of 35^{0}C. Humidity is quite high in Oyo State; relative humidity in the State is 70 percent with a maximum of about 60 percent in the evening and a maximum of around 80 percent in the morning.

3.2 Sampling technique and sampling size

Multi-stage method sampling technique was used to collect data for this study through the use of well-structured questionnaires. The first stage was the choice of selecting the existing four Agricultural Development Program (ADP) zones in the State, namely, Ibadan-Ibarapa, Oyo, Saki and Ogbomoso zones due to the existence of agroforestry farmers. The second stage involved purposive selection of one Local Government from each of the zones where agroforestry farmers are concentrated. The third stage was the proportionate selection of the agroforestry farmers from the selected local governments, this comprises of 50, 46, 40 and 40 respondents from Oyo, Ogbomoso, Ibadan / Ibarapa and Saki zones respectively making a total of 176 agroforestry farmers. Lastly, structured questionnaires were distributed to collect data from a sample of one hundred and seventy six (176) agroforestry farmers from the study areas. The sample selected was based on the proportionate population of the agroforestry farmer's concentration and availability in the register of the Oyo State Agricultural Development Program (OYSADEP).

3.3 Analytical techniques

Multiple linear regression model (Cobb Douglass production function) was used to analyze the determinants of the crop output in the study area. A derivative of production function analysis was adopted to estimate the determinants of land management practices on the level of crop production. Tobit regression analysis was used to identify the determinants of sustainable land management practices by the agroforestry farmers while fuzzy set theory was used to construct the index of sustainable land use practices and determine the status of SLMP among agroforestry farmers. Using fuzzy set theory, a set of composite farm level indicators was constructed in order to analyze different dimensions of sustainable land management which assume multidimensional responses which are discrete and continuous variables.

3.4 Model specification

$Y = b0 + b1X1 + b2\ X2 + b3X3 + b4X4 + b5X5 \ldots\ldots\ldots\ldots X11 + \mu$ (2)

$Yi = f(Xij, \alpha j)$ … (implicit form)

$Y = f(Xs)$

$Y = (X1, X2, X3, \ldots Xn)$

Linear

$$Y = a+b_1X_1+b_2X_2+b3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_9X_9+b_{10}X_{10}+b_{11}X_{11}+b_{11}X_{11}+e$$

Double log

$$LnY = a+ b_1lnX_1 + b_2lnX_2 + b_3lnX_3 + b_4lnX_4 + b_5ln\ X_5 + b_6ln\ X_6 \ldots\ldots\ldots b_{11}ln\ X_{11} +e$$

Semi-log

$$Y = a+ b_1lnX_1 + b_2lnX_2 + b_3lnX_3 + b_4lnX_4 + b_5ln\ X_5 + b_6ln\ X_6 \ldots\ldots\ldots\ldots b_{11}ln\ X_{11} +e$$

Exponential

$LnY= a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6 \ldots\ldots b_{11}X_{11} +e$

Where,

Where Y = the crop output (kg)

X_1 = Farming experience (years)

X_2 = Farm size (ha)

X_3 = Educational level (dummy)

X_4 = source of credit (dummy)

X_5= Types of Land ownerships (dummy)

X_6 = land use duration (years)

X_7 = Age of respondent (years)

X_8 = farm income (Naira)

X_9 = farm management experience (years)

X_{10} = mode of cultivation (dummy: local/manual = 0, mechanized = 1)

X_{11} = source of water (dummy)

e = error term

b = Parameter to be estimated

a = Constant

Tobit regression

Tobit regression method was used to analyze the determinants of sustainable land management practices in the study area.

The model used for the estimation was given as:

$SLMIi = A + \beta i \sum_{j=1}^{12} Zi + \mu$MIiA+βi_j=1 ^12Zi+ μ......................... (1)

$SLMIi = \beta o + \beta 1Z1 + \beta 2Z2 + \beta 3Z3 + \beta 4Z4 + \beta 5Z5 \ldots\ldots \beta 12Z12 + \mu i$.. (2)

Where; SLMI = (Sustainable Land Management Index)

Z_1= Age (Years), Z_2 = Farming experience (years), Z_3 = Income (Naira), Z_4 = Farm size (ha),

Z_5 = Organic manure application (dummy), Z_6 = Fertilizer application (dummy),

Z_7 = Continuous cropping (dummy), Z_8 = Erosion runoff (dummy), Z_9 = Pesticide application (liter), Z_{10} = Organic matter (dummy), Z_{11} = Mode of cultivation (dummy), Z_{12} = Educational level (years), μ = Error term, β = Parameter estimated, β_o= Constant

Fuzzy Logic Model

According to Betti *et al*., (2005) putting together categorical indicators of deprivation for individual items to construct composite indices requires decisions about assigning numerical values to the ordered categories and the weighting and scaling of the measures. Indicators of sustainable land use often take the form of simple 'yes/no' dichotomies. In this case Xij is $0 \leq 1$

as used by Dagum and Costa, (2004) and adopted by Oyekale, (2012).

A = (a1 ....ai ....); and.. (3)

A: X = (X1 ....Xj .... Xm).. (4)

X_{ij} = U_β ($X_1(a_1)$), 0 ≤ 1.. (5)

Wj = $\log[\sum_{j=1}^{n} g(a_i)/\sum_{j=1}^{n} x_n g(a_i)]$ .... (6)

$\mu_\beta (X_j) = \sum_{j=1}^{n} x_n g(a_i)/\sum_{j=1}^{n} g(a_i)$ j = 1, 2,..........m........... (7)

$\mu_\beta = \sum_{j=1}^{m} \mu_\beta(X_j)W_j/\sum_{j=1}^{m} w_j$ = 1, 2,........... m.....................(8)

4. RESULTS AND DISCUSSION

4.1 Regression result of the determinants of crop productivity in the study area

From Table 1, different functional models were fixed for the determinant of crop output among the farmers. Four functional forms (linear, semi log, exponential and double log) were used, but the double log was chosen. The choice of the line as function is predicated on its confirmation to *a priori* expectation in terms of signs and magnitude of the coefficient, the number of significant variables and the coefficient of multiple determinations (Olayemi and Olayide, 1981) and the significance of the overall profitability as judge by the t-value. The regression result is as shown in Table 1. The results reveal that double-log was found to be the most suitable among others to explain the result of the analysis. Therefore, it was revealed that farm size used, years of farming experience, age of farmers and income were positively significant at 1% level except for farm management experience which has a negative coefficient to the level of crop outputs but also significant at 1%. Source of water was also positively significant at 10% level. These imply that an increase in any of these variables will bring a proportionate increase in the level of crop outputs (Babalola *et al*., 2013; Oyewo *et al*., 2014) except for farm management experience which could bring about a reduction in the level of output due to the low level of years of farm land management practices experience and low level of education by the farmers which conform with the work of Oyekale, (2012). R^2 was 0.740 which shows that 74% of the variability in the level of outputs is associated with the explanatory variables specified in the model, while 26% could explain the variables that were not captured in the model.

4.2 Tobit regression of determinants of sustainable land management

The result in Table 2 shows the marginal effect of the variables used on the determinants of sustainable land management which revealed that farm size is positively related to sustainable land management (SLM) ($p<0.05$). This implies that there is probability of increasing SLM with an increase in the application of this variable (farm size). Farm size is one of the factors influencing land use intensity, a unit increase in hectare of farmland marginally increase land use as asserted by Yusuf *et al*., (2011). Farmers gross income is positively significant ($p<0.05$) to (SLM). This implies that as agroforest farmer's income increases there is likelihood that SLM will be enhanced. This is in line with the *a priori* expectation because increase in farmers income will encourage the farmers in the adoption of sustainable land management practices, this may however be due to the fact that farmer's gross farm income will encourage the farmer to operate an extensive land management system that can enhance farmland sustainability. This agrees with the work of Ogbonna *et al*., (2007) and Ikechukwu and Nwakwo (2013) that increase in income will lead to increase in the use of Sustainable Farmland Management Practices and that higher income will give the farmers more money for possible adoption of farmland management practices. This was also supported by Agboola *et al*., (2015) that farm income suggests that the larger the income earned, the greater the level of use of a particular technology and ease the capital constraint needed for soil-conservation investments.

Mode of cultivation and continuous cropping had negative relationship and significance ($p<0.05$) to sustainable land management. This implies that as the mode of cultivation (manually) by the farmers is continually practiced there is likelihood that sustainable land management may not be enhanced. This may be due to the cultural practices that the farmers are used to and unable to adopt mechanized mode of cultivation which will enhance sustainable farming. Continuous cropping also has a negative effect on agroforestry farmer's sustainability because continuous cropping on the same portion of land without fallow (allowing the land to rest) may lead to soil nutrient loss and thereby reduce sustainable management and affect the crop grown. Fertilizer and pesticide are significant ($p<0.01$) respectively while organic manure is also significant ($p<0.10$). This implies that increase in any of these variables will increase the level of sustainable land management of the agroforestry farmers as these have positive relationship to SLM and enhance agroforestry farmer's sustainability. Chi^2 value of 61.99 was significant ($p<0.01$) indicating a good fit of the model used for the study.

4.3 Contributive effects of SLM indicators to agroforestry farmer's sustainability

The result presented in Table 3 reveals that land fallowing contributed relatively 3.51% to SLMP sustainability index because same pieces of farmland were used periodically for agricultural activities without allowing the land to rest which causes soil nutrients loss and degradation. Compaction and rooting had relative contributions of 3.47% to sustainability. This may be due to the fact that compaction affects the sustaining power of the crop root to penetrate soil because of the hardness nature of the soil due to surface land exposure. Relative contribution of addition of organic manure (3.0%) is higher than that of plot level application of fertilizer 2.9% because most of the farmers were able to sustain their production through the use of organic manure than fertilizer because it is readily available at the farmers' disposal, environmentally friendly, improves soil quality and rarely overdose. Residue cover had a relative contribution of 3.47% to land sustainability.

This shows that surface residue though present, did not totally cover the soil thus given room to soil or water erosion which also contributed relatively (3.48%) to sustainable land management with high possibility of being washed or blown away the topsoil affecting the soil fertility. Seed, labor and land use intensities; minimum tillage and profit per hectare had better and higher absolute contribution to sustainable land use with 0.0049, 0.0051, 0.0065, 0.0075, and 0.0064 and relative contributions of 1.7%, 1.8%, 2.3%, 2.6% and 2.3% respectively. This shows that the agroforestry farmers' combination of these indicators contributes positively to land sustainability and could influence farmer's output positively. They also encourage soil conservation except for residue cover, wind or water erosion, compaction and rooting among others that contributes to land been unsustainable.

This conforms to the work of Agboola *et al*., (2015) that factors influencing the use of land management and conservation practices by the farming household head were determined by combination of parcel/ plot level factor, human, physical and financial capitals as well as institutional factors. However, the total computed sustainable land use index (SLUI) of 0.2761and mean computed (SLUI) of 0.0084 indicated that the agroforestry farmers were generally sustainable with the present combination of these farm level indices because the closer the index value is to zero, the better the farmers' sustainability.

5. CONCLUSION AND RECOMMENDATIONS FOR FUTURE STUDIES

The study considered different productive objectives in farmers' sustainable agricultural practices using fuzzy sets theory to compute the composite indicators of sustainable land management (ISLM) from selected farm level indicators. Cobb Douglass production function and Tobit regression were used to analyze the objectives of the study. It was therefore concluded that farming experience, farm size, age of respondents and source of irrigation and farm management experience were the major determinants of crop production; the total sustainable land use index (SLUI) was 0.2761 indicating that agroforest farmers were generally sustainable in their land use system considering the combinations of all the indicators because the closer the index value is to zero (0) and farther away from one (1) the more sustainable the farmers' practices. Also, the contributive effect of SLM indicators shows that seed, labor and land use intensities; minimum tillage, profit per hectare have better absolute contributions to sustainable land use management and enhance the sustainability of the agroforestry farmers except for land fallowing, residue cover, wind or water erosion, compaction and rooting among others contributed to land been unsustainable. Tobit analysis shows that farmer's income, farm size, organic manure, fertilizer and pesticide application and mode of cultivation were the major determinants of sustainable land management though continuous cropping and mode of cultivation were negatively signed which may have negative effect on agroforestry in the study area.

It is therefore recommended that agroforestry farmers should be sensitized on the need to be discouraged on manual cultivation and embrace mechanized mode of cultivation which may enhance farmers sustainable land management and in increase farmer's productivity. Also, continuous cropping could be encouraged if the present land is properly managed with the present combination of sustainable land management indictors and better agronomic practices since the available land is competing with other non-agricultural activities such as land tenure system. It was further suggested that this research work could be carried out among other food crops in western and Sub-Sahara Africa.

REFERENCES

Adama J.I (2016). Transformation of Agricultural Education in Nigeria: Implication for Food Security. *Journal of Economics and Sustainable Development*. 7(7): pp.1-7.

Agboola, W.L., Yusuf, A.L., Oyekale, A.S., Salman, K.K. (2015). Determinants of Land Management Practices among Food Crop Farmers in North Central Nigeria. *Journal of Environment and Earth Science*. 5 (21):36-44.

Betti, G., Cheli, B., Lemmi, A. and Verma, V. (2008). The fuzzy set approach to multidimensional poverty: the case of Italy in the 1990s. *Quantitative approaches to multidimensional poverty measurement*, 30-48.

Dagum, C., & Costa, M. (2004). *Analysis and measurement of poverty. Univariate and multivariate approaches and their policy implications. A case study: Italy* (pp. 221-271). Physica-Verlag HD.

Approaches and their Policy Implications: A case study of Italy" In Dagum C. and Ferrari G. (eds.); Household Behavior, Equivalence Scales, Welfare and Poverty, Springer Verlag, Germany.

Dumanski, J. and Smyth, A. J. (1994). The issues and challenges of sustainable land management. In *Proc. International Workshop on Sustainable Land Management for the 21st Century. Agricultural Institute of Canada, Ottawa* (Vol. 381).

Proceedings. International Workshop on Sustainable Land Management for the 21st Century. In Wood, R.C. and

Dumanski, J. (Eds). Vol. 2: Plenary Papers. Agricultural Institute of Canada, Ottawa. Pp 381.

Eni, I (2012) Effects of Land Degradation on Soil Fertility: A Case Study of Calabar South, Nigeria. In (Ed), Environmental Land Use Planning. Intech Open. Pp 40776

FAO. (2009). Country Support Tool-for Scaling up Sustainable Land Management in Sub-Sharan Africa. Food and Agriculture Organization of the United Nations, Rome, Italy.

Gazali, I and Audu, A (2020). Sustainable Land Management Practices and Technical and Environmental Efficiency among Smallholder Farmers in Ghana. *Journal of Agricultural and Applied Economics*, (52): 96-116

Ikechukwu, I. Iand Nwakwo, O. C. (2013). Socio-Economic Determinants of Farmland Managements Practices in Umuahia North Local Government Area, Abia State, Nigeria. *Journal of Agriculture and Social Research*. 13 (1): 50-55.

Ministry of Food and Agriculture (2016). Agricultural Sector Repots 2015, (MoFA), Accra Ghana.

Navidi, M. N., Seyedmohammadi, J., & McDowell, R. W. (2022). A proposed new approach to identify limiting factors in assessing land suitability for sustainable land management. *Communications in Soil Science and Plant Analysis*, *53*(19), 2558-2573.

Factors in Assessing Land Suitability for Sustainable Land Management, *Communications in Soil Science and Plant Analysis*, 53(19): 2558-2573

NPC, (2006). National Population Commission, Abuja Nigeria.

Ogbonna, K.I., Idiong, I.C and Ndifon, H.M. (2007). Adoption of Soil Management and Conservation Technologies by Small Scale Crop Farmers in Southeastern Nigeria: Implications for Sustainable Crop Production. *Agricultural Journal*, 2(2): 294-298.

Ogunkunle, A. O. (2004). "Soil Survey and Sustainable Land Management". Paper presented at Annual Conference of Soil Science Society of Nigeria Abeokuta 24 pp.

Oyekale, A.S. (2012). Fuzzy Indicator of Sustainable Land Management and Its Correlates in Osun State, Nigeria. *Journal of Human Ecology*, 39(3): 175-182.

Oyewo, I.O(2018): Effect of Sustainable Land Management Practices on Smallholder Cassava Farmers Productivity in Oyo State Nigeria. (Unpublished PhD Thesis), pp 108.

Sulo, T and Chelangat, S (2012). An Econometrics Assessment of f Food Security Estimation Using Fuzzy logic: A case in the Arid and semi Arid Lands of Kenya. *Global Journal of Science Frontier Research Agriculture and Veterinary Sciences*. 12(9): 6-13.

Watkins, K.B, Gealy, D.R, Anders, M.M. and Mane. R.U. (2018) "An Economic Risk Analysis of Weed Suppressive Rice Cultivars in Conventional Rice Production." *Journal of Agricultural and Applied Economics*, 50: (4), 478-502.

Yusuf, S.A., Odutuyo, O. E and Ashagidigbi, W. M. (2011). Agricultural Intensification and Poverty in Oyo State. *World Rural Observations*. 3(4):98-106.

Journal of Integrated Sciences
Volume 3, Issue 1, December 2022
ISSN: 2806-4801

APPENDICES

Table 1: Regression analysis of the determinants of crop production in the study area

Variable	Linear	Double log	Exponential	Semi-log
Constant	7.106	-0.054	1.084	-76.377
= Farming experience	0.428***	0.172***	0.005***	13.911***
	(3.114)	(3.800)	(3.128)	(3.197)
= Farm size	4.293***	0.0572***	0.045***	48.150***
	(4.764)	(8.875)	(4.266)	(7.768)
= Educational level	-1.148	-0.058	-0.015	-2.499
	(-0.856)	(-0.933)	(-0.936)	(0.419)
= source of credit	-0.647	-0.005	-0.002	-2.541
	(-0.629)	(-0.075)	(-0.196)	(-0.421)
= Types of Land ownerships	1.275	0.088	0.011	11.594*
	(1.027)	(1.289)	(0.742)	(1.766)
= land use duration	0.046	-0.063	-0.002	-5.060
	(0.227)	(-1-155)	(0.011)	(-0.961)
= Age of respondent	0.144	0.240***	0.003**	10.155
	(1.474)	(2.013)	(2.321)	(0.883)
= farm income	0.003***	0.187***	-0.000***	15.584**
	(1.474)	(2.647)	(3.760)	(2.292)
= farm mgt experience	-0.605***	-0.204***	-0.007***	-16.757***
	(-3.014)	(-3.682)	(-2.785)	(-3.146)
= mode of cultivation	3.772	0.036	0.054*	2.489
	(1.474)	(1.460)	(1.815)	(-0.872)
= source of irrigation	4.758*	0.048*	0.040	5-216**
	(1.661)	(1.746)	(1.179)	(1.059)
	0.622	0.740	0.611	0.678
atistics	22.316	38.570	21.336	28.613

ce: author regression. (*) = 10%; (**) = 5%; (***) = 1% significant.
: Values in parenthesis are t-values

Journal of Integrated Sciences
Volume 3, Issue 1, December 2022
ISSN: 2806-4801

Table 2: Tobit analysis of the Determinants of Sustainable Land Management

Variable	Coefficient	dy/dx	Standard error	T-statistic
Constant	0.2022		0.0614	3.29
Z_1= Age	0.0009	0.0009	0.0092	0.10
Z_2 = Farming experience	0.0009	0.0009	0.0012	0.77
Z_3 = Income	0.0094**	00094**	0.0038	2.48
Z_4 = Farm size	0.0193**	0.0193**	0.0079	2.45
Z_5 = Organic manure	0.0347*	0.0347*	0.0208	1.67
Z_6 = Fertilizer application	0.1707***	0.1707***	0.0273	6.25
Z_7 = Continuous cropping	-0.0494**	-0.0494**	0.0222	-2.22
Z_8 = Erosion runoff	0.0188	0.0188	0.0220	0.85
Z_9 = Pesticide application	0.0807***	0.0807***	0.0253	3.20
Z_{10} = Organic matter	0.0473	0.0473	0.0319	1.48
Z_{11} = Mode of cultivation	-0.0524**	-0.0524**	0.0217	-2.41
Z_{12} = Educational level	0.0033	0.0033	0.0116	0.28
Sigma	0.1223			
Chi^2 (12)	61.99***			

Source: Authors Data Analysis. * implies, p<0.10; ** implies, p<0.05; *** implies p<0.01.

Journal of Integrated Sciences
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ISSN: 2806-4801

Table 3: Contributive effect of SLM indicators to agro forest farmers' sustainability using fuzzy logic

SLM Indicators	*Absolute contribution	**Relative contribution (%)
Vigor of crop yield	0.0072	2.607750815
Trend of vegetative covers	0.0093	3.368344803
Residue cover	0.0096	3.477001087
Crop yield	0.0081	2.933719667
Labor productivity	0.0074	2.680188338
Profit per hectares	0.0064	2.318000724
Organic matter contents	0.0089	3.223469757
Drainage/infiltration of water	0.0095	3.440782325
Water holding capacity	0.0093	3.368344803
Aggregation of soil	0.0095	3.440782325
Earthworm/ soil life	0.0081	2.933719667
Compaction and rooting	0.0096	3.477001087
Crusting/emergency	0.0090	3.259688519
Tilth/ workability	0.0094	3.404563564
Wind or water erosion	0.0096	3.477001087
Salinity	0.0086	3.114813473
Plot level application fertilizer	0.0082	2.969938428
Addition of organic manure	0.0083	3.006157189
Mulching of crops	0.0095	3.440782325
Minimum tillage	0.0075	2.716407099
Cover crops	0.0088	3.187250996
Rotation of crops	0.0085	3.078594712
Land fallowing	0.0097	3.513219848
Irrigation Water level	0.0079	2.861282144
Irrigation Water quality	0.0085	3.078594712
Use of Pesticide	0.0096	3.477001087
Use of Herbicide	0.0079	2.861282144
Use of chemical poison	0.0075	2.716407099
Industrial discharges	0.0089	3.223469757
Land use intensity	0.0065	2.354219486
Labor use intensity	0.0051	1.847156827
Type of seeds	0.0089	3.223469757
Seed use intensity	0.0049	1.774719305
Mean Computed (SLUI)	0.0084	3.042375951
Total Computed (SLUI)	0.2761	100

Author computation

Note: