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# Soil conservation techniques among arable crop farmers in Odo Otin local government area, Osun state: A multinomial logit approach

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**The study investigated the soil conservation techniques among the arable farmers in Odo Otin local government area of Osun State. Two-stage sampling procedure was employed for the study. Primary data were collected from 120 arable crop farmers in the Local Government Area. Data collected were analysed using descriptive statistics; multinomial logit regression model. Result shows that most the respondents were aware of various soil conservation and mulching/cover cropping were prominent. The result further shows that farm size is positively significant in mulching/cover cropping and shifting cultivation/bush fallowing influenced soil conservation techniques adoption. The study recommends improved conservation technology initiative aimed at enabling local farmers to adopt technology conducive to increasing income as well as to enhancing soil conservation. Also, local institutions should be strengthened and their members empowered such that they can run effective institutions and promote technology adoption at the local level themselves.**

**Key words:** Awareness, arable crop farmers, soil conservation techniques, multinomial logit model.

## INTRODUCTION

Soil undoubtedly plays pivotal roles in the agricultural production systems. As a medium that physically supports crop and animal growth, the sustainability of crop productivity also depends on the quality of soil. Though a fixed asset, soil is primarily essential to guarantee food security, industrial crop production and improved household financial status (Anjichi et al., 2007). In the tropics (Nigeria inclusive), soil fertility deterioration is a common form of degradation, which is increasingly threatening the sustainable agricultural production of smallholder farmers whose livelihoods partly or wholly depend on soil.

Soil conservation techniques are a set of management antidotes needed to prevent the topsoil from being

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eroded or the soil from being degraded chemically or structurally due to overuse (Lal, 2015). In the management parlance, the essence of soil conservation is to prevent or minimize waste while guaranteeing a continuous availability of soil resource to support agricultural production and preserving environment aesthetics (Acosta–Martínez et al., 2017; Blanke et al., 2007; Schwab et al., 1993).

However, the declining soil productivity coupled with incompatible land use methods will not only translate to decreasing food crop production but also threaten and endanger production of cash crops for export. In Nigeria, various soil conservation technologies such as planting of multipurpose tree hedgerows, contour vegetative hedges of vetiver, minimum tillage, double cropping, the establishment of cover crops and mineral fertilizers have been introduced to farmers through various participatory methods like establishment of Small Plot Adoption Techniques (SPATs) and demonstration plots by both governmental- and non-governmental organizations.

However, soil conservation practice adoption is a multi-dimensional process and numerous factors determine farmers' attitude towards a particular soil conservation practice. In addition, the complexity and inter-relationship of these myriad of socioeconomic and farm-specific factors largely are responsible for farmer's choices among the available soil conservation practices. Smallholder farmers' goal of production is gradually moving away from pure subsistence to commerce. Hence, much more than the preservation of the environment and soil, issues generally perceived to guarantee household's daily survival form the basis of soil conservation practices. In this regards it becomes pertinent to know the soil conservation technique use of food crop farmer in the study area.

## Theoretical/conceptual framework and literature review

Soil is the most important resource in agriculture production to realize basic requirements of food and shelter of man. Conservation of soil resource is vital for sustainability of agriculture and environment. Soil resource is under incalculable pressure due to ever increasing population thereby ensuing growing need for food for the populace. Soil conservation is a set of management strategies for prevention of soil being eroded from the earth's surface or becoming chemically altered by overuse, salinization acidification, or other chemical soil contamination (Seenga, 2014; Dimelu et al., 2013; Ezeaku, 2012). Soil conservation technique is the application of processes to the solving of soil management problems. The type of soil management techniques employ by farmers is essential for maximizing the production of agricultural commodities and is also important for preventing degradation of farm land (Powlson et al., 2011; Shah and Wu, 2019). Dumanski and Peiretti (2013) summarizes some of the modern approaches, ranging from no till to conservation agriculture to sustainable land management. The study found that these approaches are not separate, but components of a continuum of conservation approaches applicable at different levels and different scales. Conservation agriculture employs all modern technologies that enhance the quality and ecological integrity of the soil, but the application of these is tempered with traditional knowledge of soil husbandry gained from generations of successful farmers (Dumask et al., 2006). In the paradigm of conservation tillage, Dumansk et al. (2006) concluded that technique promotes minimum disturbance of the soil by different agricultural and non-agricultural practices, reduce long-term dependency on external inputs which often times led to increased cost of production, reduced emission of greenhouse gases and improved agricultural productivity. The major motives indicated for use of soil conservation practices among farmers are enhanced productivity, high quality products, long term nutrient value (Dimelu et al., 2013) and others include farm size, and awareness of the techniques, insufficient fund, unfavourable land tenure system, inadequate information, little technical know-how, soil conservation skills and farmers' literacy level (Bello et al., 2016; Ademola and Olujide, 2014; Babalola and Olayemi, 2013). According to Amsalu and De-Graaff (2007), most of the farmers who invest in soil conservation measures are those with large farms size and most of them time risk takers.

## MATERIALS AND METHODS

### Area of study

The study was carried out in Odo Otin Local Government Area of Osun State. Odo Otin Local Government has its headquarters in Okuku Town at 8° 05'N 4° 77'E. It is bound in the west by Ogbomoso, east by Ila Orangun, south by Ifelodun and north by Kwara State. Odo Otin Local Government with an area of 294 $km^2$ and has a population of 134,110 (NPC, 2006). Major towns in the Local Government are Oyan, Igbaye, Inisha, Ekosin, Okua and Okuku. The people are mainly Ibolos with trading and farming as their predominant occupation. Arable crops been planted by the people include sorghum, sweet potatoes, maize, cassava, coco yam and yam while cash crops include cocoa, kolanut, coffee and oil palm.

### Sampling procedure

Two-stage random sampling was used in the selection of the respondent crop farmers from within the study area. Primary data were collected through well-structured questionnaires administered to the crop farmers in the study area. Information collected included socio-economic/demographic characteristics, farming and non-farming activities, ownership of land, farm size, awareness and

adoption of soil conservation techniques, group or association membership, etc. The first stage of the sampling involved random selection of four villages in the local government area. In the second stage, thirty-one arable crop farmers were selected for interview from each of these villages. In all, a total of 120 completely filled questionnaires by farmers were used for the analysis.

**Analytical tool**

Descriptive statistics and multinomial logit model were employed for the study.

***Descriptive***

Descriptive statistic included the table, frequency, mean, standard deviation and percentage.

***Multinomial logit model***

The multinomial logit (MNL) model was used to analyse the determinants of farmers' choice of adaptation methods. This method can be used to analyze crop (Kurukulasuriya and Mendelsohn, 2006) and livestock (Seo and Mendelsohn, 2006) choices as methods to adapt to the negative impacts of climate change. The advantage of the MNL is that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories (Wooldridge, 2002). Moreover, Koch (2007) emphasizes the usefulness of this model by describing the ease of interpreting estimates from this model. To describe the MNL model, let *y* denote a random variable taking on the values {1, 2...*J*} for *J* , a positive integer, and let *x* denote a set of conditioning variables. In this case, *y* denotes adaptation options or categories and *x* contains household attributes like sex, age, marital status, household size, farm size, membership of association and access to credit. The independent variables specified as factors influencing the adoption of soil conservation practices are defined below:

$X_1$ = Gender (Male = 1, Female = 0); $X_2$ = Age of Household Head (Years); $X_3$ = Marital status (Married =1; 0 = Otherwise); $X_4$ = Household size (Number); $X_5$ = Year spent in school (Year); $X_6$ = Farm size (Hectares); $X_7$ = Membership of association (Yes = 1, No = 0); $X_8$ = Membership of farmer group/association (Yes = 1, No = 0) and $X_9$ = Access to credit (Yes = 1, No = 0).

The question is how ceteris paribus changes in the elements of *x* affect the response probabilities *P*(y = *j* / *x*), *j* =1, 2 ...J. Since the probabilities must sum to unity, *P*(y = *j* / *x*) is determined once we know the probabilities for *j* = 2..*j*. Let x be a 1× k vector with first element unity. The MNL has response probabilities:

$$P(y=j / x) = \exp(x\beta j) / [1+\sum_{h=1}^{j} \exp(x\beta h) \text{ , } j = 1 \ldots j] \quad (1)$$

Where, βj is k×1, j = 1……..j

Unbiased and consistent parameter estimates of the MNL model in equation (16) require the assumption of independence of irrelevant alternatives (IIA) to hold. More specifically, the IIA assumption requires that the probability of using a certain adaptation method by a given household needs to be independent from the probability of choosing another adaptation method (that is, *Pj/Pk* is independent of the remaining probabilities). The premise of the IIA assumption is the independent and homoscedastic disturbance terms of the basic model in equation (1).

The parameter estimates of the MNL model provide only the direction of the effect of the independent variables on the dependent (response) variable, but estimates do not represent either the actual magnitude of change nor probabilities. Differentiating Equation 1 with respect to the explanatory variables provides marginal effects of the explanatory variables given as:

$$\frac{\partial pj}{\partial xk} = pj(\beta jk - \sum_{j=1}^{j-1} pj\beta jk) \quad (2)$$

The marginal effects or marginal probabilities are functions of the probability itself and measure the expected change in probability of a particular choice being made with respect to a unit change in the independent variable from the mean (Green, 2003; Koch, 2007).

## RESULTS AND DISCUSSION

Table 1 presents the distribution of farmers by selected socio-economic and demographic characteristics and farm specific variable. The result shows that majority (61.7%) of the farmers were male. The implication is that food crop farming in the study area is dominated by male farmers. Most (49.2%) of the respondent farmers were between ages 41 and 50 years with only a few above 50 years of age. The mean age of the respondent crop farmers was 44.2 years, implying that a higher percentage of the crop farmers in the study area were young and agile and possess ability and energy to contribute meaningfully to crop production and implement various soil conservation practices. Household size in the study area was high with crop farmer had an average of 7 members. This implies that most of the crop farmers in the study area with relatively large household size will find it difficult to adopt some soil conservation practices because of the implication on their finances.

Educated people are more receptive to agricultural innovation than the old and illiterate farmers. Almost half (48.3%) of the crop farmers were illiterate with non-formal education. The implication is that there is tendency for farmers no education might find it difficult to adopt soil conservation technique. Most crop farmers (48.3%) in study area had farming as their primary occupation while others 22.5, 20.0 and 9.2% were traders, civil servants and other jobs respectively. This implies that most respondents in the study area are farmers and likely aware soil conservation practices. Land ownership is a very important determinant of adoption of soil conservation techniques, because of lack of access to farm land makes it practically impossible for farmers to embark on any soil conservation technique. The result shows that majority (83.3%) of the respondents had farmlands of their own acquiring through inheritance while the remaining secured their land through other means (rent, purchase, borrowed). Half of the crop farmers had farm size of at most one hectare. The mean

**Table 1.** Distribution of farmers by selected socio-economic and demographic characteristics and farm specific variable.

| Variable | Frequency | Percentage |
|---|---|---|
| **Gender** | | |
| Female | 46 | 38.3 |
| Male | 74 | 61.7 |
| Total | 120 | 100 |
| | | |
| **Age** | | |
| <30 | 10 | 8.3 |
| 31-40 | 26 | 21.7 |
| 41-50 | 59 | 49.2 |
| >50 | 25 | 20.8 |
| Total | 120 | 100.0 |
| Mean= 44.2, SD=1.1 | | |
| | | |
| **Household size** | | |
| Less than 5 | 30 | 25.0 |
| 5-9 | 80 | 56.7 |
| Above 9 | 10 | 8.3 |
| Total | 120 | 100.0 |
| Mean= 7.0 SD=0.1 | | |
| | | |
| **Educational qualification** | | |
| No formal education | 42 | 35.0 |
| Primary | 35 | 29.2 |
| Secondary | 39 | 32.5 |
| Tertiary | 4 | 3.3 |
| Total | 120 | 100.0 |
| | | |
| **Primary occupation** | | |
| Farming | 58 | 48.3 |
| Trading | 27 | 22.5 |
| Civil servant | 24 | 20.0 |
| Others | 11 | 9.2 |
| Total | 120 | 100.0 |
| | | |
| **Land ownership** | | |
| Inheritance | 100 | 83.3 |
| Rent | 3 | 2.5 |
| Borrowed | 11 | 9.2 |
| Lease/purchase | 6 | 5.0 |
| Total | 120 | 100.0 |
| | | |
| **Farm size (ha)** | | |
| <0.50 | 15 | 12.5 |
| 0.50-1.00 | 45 | 37.5 |
| 1.10-1.50 | 40 | 33.3 |
| 1.51-2.00 | 14 | 11.7 |
| >2.00 | 6 | 5.0 |
| Total | 120 | 100.0 |

**Table 1. Cont.d**

| | | |
|---|---|---|
| Mean=1.01, SD=0.12 | | |
| **Membership of association** | | |
| Yes | 44 | 36.7 |
| No | 76 | 63.3 |
| Total | 120 | 100.0 |
| Total | 120 | 100.0 |
| **Soil conservation technique awareness** | | |
| No | 22 | 18.3 |
| Yes | 98 | 81.7 |
| Total | 120 | 100.0 |

Source: Field Survey (2016).

**Table 2.** Different types of soil conservation methods used by farmers in the study area.

| Selected technique | Frequency | Percentage |
|---|---|---|
| Manuring and inorganic fertilizer | 38 | 31.7 |
| Mulching/ cover cropping | 49 | 40.8 |
| Shifting cultivation/bush fallowing | 18 | 15.5 |
| Crop rotation | 15 | 12.5 |
| Total | 120 | 100.0 |

Source: Field Survey (2016).

farm size in the study area was 1.01 hectare. Result further shows that 63.3% of the respondents did not belong to any farmers' group or association. The implication is that the categories of farmers might be excluded from the various benefits (economic gains and spiritual) derive from being members of social networks, such as cooperatives, farmers union etc. Group or association membership is needed to increase awareness on various agricultural innovations, and hence increases likelihood of adoption. The result supports Balogun (2011) that contribution and participation in group activities create economic gains and spiritual benefits. The result shows that 81.7% of the respondents were aware of various soil conservation techniques and actually employed some in their farms, while remaining were not.

Different types of soil conservation methods used by farmers in the study area are presented in Table 2. The result reveals that the prominent soil conservation method used in the study area by farmers was mulching/cover cropping (40.8) followed by manuring and inorganic fertilizer (31.7%) as a means of maintaining the condition of their farm lands. The least frequent use was crop rotation (12.5%). The reason might be that area of land available for agriculture has continued to decline marginally because the area is located within the derived savannah region of the country.

Table 3 presents determinants of adoption of soil conservation techniques by farmers. The dependent variables defined as manuring and inorganic fertilizer, mulching/cover cropping, shifting cultivation/bush fallowing as well as crop rotation. The dependent variable manuring and inorganic fertilizer was used as the base category or reference cell. The Chi-square distributions was used to test overall model adequacy at specific significant level. Likelihood ratio also determines whether the multinomial logit model is preferable to binomial logit model. The result shows that the coefficient of age of the farmer, household size, farm size and access to credit were significant variables determining adoption of soil conservation technique by farmers. The coefficient of age is positively significant at ($P<0.05$) for farmers adopting shifting cultivation/bush fallowing soil conservation techniques, implying that the higher the age of the farmers, the higher their probability of adopting soil Shifting cultivation/Bush fallowing conservation techniques. This implies that a year increase in the age of farmer would increase the likelihood of adopting shifting

**Table 3.** Determinants of adoption of soil conservation techniques by farmers.

| Explanatory variable | Mulching/cover cropping | | Shifting cultivation/bush fallowing | | Crop rotation | |
|---|---|---|---|---|---|---|
| | Coefficient | Marginal effect | Coefficient | Marginal effect | Coefficient | Marginal effect |
| Sex of farmer | -0.54311(-0.82) | -0.03787 | -0.08296 (-0.08) | -0.03384 | -1.04344(-1.33) | -0.132517 |
| Age of farmer | 0.01749 (0.50) | -0.00410 | 0.08768 (2.13)** | 0.006173 | 0.072025 (1.89)* | 0.008081 |
| Marital status | -0.42229(-0.47) | -0.05036 | -0.20154 (-0.18) | 0.008601 | -0.54127(-0.54) | -0.051167 |
| Household size | -0.11561(-0.77) | -0.01653 | -0.454786 (-2.07)** | -0.030796 | -0.38816-(1.95)* | -0.042477 |
| Years spent in school | -0.01978 (-0.36) | -0.00035 | -0.00430(-0.06) | -0.001523 | -0.060036 (-0.84) | -0.007747 |
| Farm size | 0.4386(2.17)** | 0.06239 | 0.49816 (2.03)** | 0.024656 | 0.29210 (1.17) | 0.0053278 |
| Membership of association | 0.01701(1.33) | 0.13339 | -0.601799(-0.62) | -0.09873 | 1.01182 (1.34) | 0.1107157 |
| Access to credit | - 0.9338(-1.30) | -0.01265 | -1.63477(-1.86) | -0.08882 | -1.62450(-2.00)** | -0.15596 |
| Constant | 0.14524(0.10) | | -2.22046(-1.28) | | -0.15446 (-0.10) | |
| No of Observation | 97 | | | | | |
| Pseudo $R^2$ | 0.1583 | | | | | |
| Log likelihood | -108.384 | | | | | |

Absolute value of z statistics in parentheses, * significant at 10%, ** significant at 5% and *** significant at 1% Omitted category in the dependent variables are the (Others such as use of fertilizer, Manure).
Source: Field Survey (2016).

cultivation/bush fallowing soil conservation techniques by 0.006173 units.

Household size with a negative coefficient is significant at five percent level. This implies that an additional member to family reduces the probability of using shifting cultivation/bush fallowing conservation techniques by 0.03% ($p<0.05$). The reason is that additional crop farmers to the household will tend to reduce the areas of land that can be left uncultivated for some years for the land to rest.

Farm size is positively significant in mulching/cover cropping and shifting cultivation/bush fallowing in soil conservation techniques at ($p<0.05$). Thus, if the farm size is increase by one hectare, lead to likelihood of farmer adoption of mulching/cover cropping and shifting cultivation/bush fallowing soil conservation techniques by 0.0623 units and 0.0246 units respectively.

In the case of access to credit, the coefficient is negative and significant ($P<0.05$). This implies that better access to credit by crop farmers decreased the likelihood of adoption of crop rotation soil conservation techniques by 0.16%.

## CONCLUSION AND RECOMMENDATIONS

The need to improve land management is obvious in the changing environment of Nigerian agriculture. Due to this, in this study special attention was paid to rural areas where land relations have profound implications for agricultural productivity, environmental sustainability and the economic and social status of rural households. The study examined study examined soil conservation techniques among the food crop farmers in Odo Otin local government area of Osun State Nigeria. The result of the analysis showed that most of the respondents were not members of farmer's association and aware of various soil conservation techniques that could be adopted in their farms. Most farmers used mulching/cover cropping as a means of maintaining the condition of their farm lands. The determinant of adoption of soil conservation techniques employed by farmers showed that farm size is positively significant in mulching/cover cropping and shifting cultivation/bush fallowing in soil conservation techniques at ($p<0.05$). The findings of this study have important policy implications for the adoption of improved soil conservation technology. Any further improved conservation technology initiative

should aim at enabling local farmers to adopt technology conducive to increasing income as well as to enhancing soil conservation. Hence, local institutions should be strengthened and their members empowered such that they can run effective institutions and promote technology adoption at the local level themselves.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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