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Determinants Of Adoption Of Soil Conservation Technologies Among Smallholder Farmers In Izzi Local Government Area Of Ebonyi State, Nigeria

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Abstract
The study examined the determinants of adoption of soil conservation technologies among smallholder farmers in Izzi Local Government Area, Ebonyi State, Nigeria. Multistage sampling technique was used to select 160 respondents for the study. Data collected with the aid of structured questionnaire were analyzed using descriptive and inferential statistics. Results showed that farmers in the area had average age of 47 years and operated on 1.5 hectares of land with an average farm income of ₦152,125. Further analysis revealed that the smallholder farmers had an adoption index of 2.21 which implied that they used at least two (2) soil conservation technologies with an average source of information of 2.72 showing that they got information on soil conservation technologies from at least three different sources. Furthermore, results revealed erosion, deforestation, reduced soil fertility and indiscriminate bush burning as the forms of soil degradation existing in the area while adopted coping strategies were crop rotation, use of organic manure, intercropping practices, appropriate use of fertilizer, use of mixed cropping system and planting of trees. The results of OLS multiple regression analysis showed that the coefficient of multiple determination (R^2) of the regression model was 0.760. This implies that seventy-six percent (76%) of the variations in level of soil conservation technology adoption were accounted for by the independent variables socio-economic characteristics of the smallholder farmers included in the model. The result of factor analysis identified social, institutional and economic factors as constraints militating against adoption of soil conservation technologies among the smallholder farmers in the study area. The rejected hypothesis concluded that there is a significant relationship between the socio-economic characteristics of smallholder farmers and their adoption of soil conservation technologies in the area. Based on the findings, the study recommends; that local government authorities and NGOs working in areas that are prone to soil fertility losses should introduce programmes that will train and promote soil conservation technologies to be adopted by farmers to improve productivity; provision of Infrastructural facilities such as good road network to ensure easy movement of agricultural inputs to the farmers field; and Agricultural extension services which are saddled with the responsibility of disseminating timely, complete actionable information should be re-positioned and strengthened to ensure smallholder farmers access to information, through appropriate channels.

Keywords*: Determinants, Adoption, Soil, Conservation, Technologies, Smallholder, Farmers*

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I. Introduction

Soil can be defined as a natural body of loose and unconsolidated materials found on the earth's surface; it is derived from weathered parent rock materials and decaying organic matters and it is composed of solid particles with liquid and gases occupying the spaces between the particles (Rayanna, Silva, Straaten, Nascimento, Biondi, Silva, and Filho, (2022). It is on this solid that most agricultural as well as non-agricultural activities take place. The food we eat, the raw materials needed by the industries are derived from there, directly or indirectly. Hence, an enduring food security will depend on a sustainable and productive resource base (Ahmed and Muhammed 2024).

In Nigeria, soil erosion is the most wide spread type of soil degradation and has been recognized for a long time as a serious problem (Gaurav, Lekhandra, Digvijay, AkshitKukreti and Surjeet, 2023). According to

Mahmud, (2023), land degradation is a major factor militating against agricultural productivity in Africa. This poses a great threat to livelihood of farm families in Africa, Nigeria inclusive. It is on this note that, Nwofoke, and Azizi, (2024) stated that soil erosion is a worldwide problem, particularly in the tropics where rainfall is high and intense. They further pointed out that soil erosion has been recognized for a long time as a serious problem in Nigeria. Alos, Nwofoke, and Azizi, (2024) reported that the causes of land degradation include such factors as population pressure on resources; poverty; high costs or limited access of farmers to fertilizers, fuel and animal feed; insecure land tenure; limited farmer knowledge of improved integrated soil and water management measures; and limited or lack of access to credit. It is in this light that Alufah, Shisanya and Obando (2012) argued that by the year 2020, soil erosion may pose a serious threat to food production and rural (as well as urban) livelihoods particularly in poor and densely populated areas of the developing world. They further advocated for policies that would encourage soil retention strategies, land improving investments and better land management if developing countries are to sustainably meet the food needs of their populations.

Soil conservation is an investment to enhance the future productive capacity of the soil, it implies reducing risks of soil erosion to a tolerable limit (Lapar and Pandey, 1999). It is also a set of management strategies for prevention of the soil being eroded from the earth's surface or becoming chemically altered by overuse, salinization, acidification, or other chemical soil contamination (Pagiola, 1993 in Onuoha 2010). Kabubo-Mariaura *et al.,* (2010) also foresighted that land conservation entails fertility management which involves the use of such technologies as mulching, cover cropping, tree planting, among others. The need for soil conservation arises due to signs of deteriorating agricultural environments which include erosion, flood disaster, desert encroachment and drought, deforestation, loss of land to other uses; if not checked, the soil becomes degraded. Ohaeri, (2000) in Onuoha (2010) stated that soil degradation is a reduction in the land's actual or potential uses. He further added that if this occurs, productivity is affected, leading to a rise in the level of inputs and hence, costs needed to restore soil productivity. However, soil conservation is a long tradition in Sub-Saharan Africa (SSA). In Nigeria, indigenous technologies, such as ridging, mulching, constructing earth bunds and terraces, multiple cropping, fallowing and the planting of trees, were performed in the pre-colonial era and combined erosion control with water conservation (Igbokwe, 1996 in Junge *et al* ., 2009).

In the words of Mugonla, Deckersa, Poesen, Isabrye, and Mthijs (2013), restoring agricultural productivity requires the promotion and adoption of farm-level conservation technologies that are meant to reduce soil degradation. They further asserted that various agricultural and non-agricultural processes and practices are known to cause different forms of soil degradation, among which are soil erosion, soil toxicity, soil pollution, poor land use regime such as bush burning. According to Kabubo-Mariaura *et al.,* (2010), there are various conservation technologies which farmers can adopt to reduce the severity of poor productivity and poverty, which are mainly runoff management technologies or fertility sustaining technologies. The adoption of these technologies, which usually involves risk among the farmers, may be influenced by several factors. It is on this point that, Bekele and Mekonnen, (2010) in their work in Ethiopia reported that land and non-land factors affect farmers' decision at household plot-level to adopt conservation technologies. The land factors include farm size and tenure arrangement among others while the non-land factors are asset holdings (e.g. livestock) and income level. They also added that institutional factors such as access to extension and membership of association affect farmers' decision to adopt land conservation measures.

However, Ezeaku (2012), asserted that, soil conservation technologies are those management strategies adopted by farmers to prevent soil from being eroded or becoming chemically altered by overuse, salinization, acidification, or other soil chemicals contamination. According to him, these strategies involve the combination of methods of management and land use to guard against soil depletion or deterioration by natural or man-induced factors. Thus, effective soil conservation practices reduce land and water pollution; reduce long-term dependency on external inputs which often led to increased cost of production; enhance environmental management, improved water quality and water use efficiency, reduced emission of greenhouse gases through lessened use of fossil fuel and finally improved agricultural productivity with minimum cost (Dimelu, Ogbonna, and Enwelu, 2013). Dimelu *et al.* (2013) opined that the use of these practices has considerably sustained production at least on subsistence level, but their long-term impacts relative to adapting and mitigating the problems of climate variability should be of concern. Therefore, the adoption of appropriate soil management measure would help to improve soil quality by enhancing soil organic matter reserves, strengthening nutrients recycling mechanisms, and raise the activities and species diversity of soil fauna (e.g. earthworms, termites, soil microorganisms).

Soil conservation technologies are known to play an important role in improving farm incomes. For this reason, substantial investments have been made in research to improve agricultural technologies in various parts of the world, from the development of new crop varieties to new practices of soil management (Kabubo-Mariara, 2006 in Owombo and Idumah, 2015). Consequently, reports indicate that these conservation structures have not been as successful as they could be, because the farmers were not enthusiastic enough in accepting widely and maintaining the soil and water conservation practices (Betru, 2002 in Kassa and Teshome, 2015). It

is in this light that Belay (1992), in Kassa and Teshome (2015) opined that the failure of conservation practices partly emerges from the fact that planners and implementing agencies ignore or fail to consider socio-cultural factors as key determinants of the success or failure of conservation programs. It is in this context that, World Bank (2007) in Addisu *et al*., (2015) reported that to protect soil resources from erosion, considerable efforts should be made to ensure the life continuity in the future. However, achieving sustainable pathways out of the downward spiral of land degradation and poverty requires that farmers adopt profitable and sustainable land management practices, or pursue alternative livelihood strategies that are less demanding of the land resource.

Livelihoods of most of the rural households in Nigeria are dependent on land. The land resource has been employed in varied proportions to meet both subsistence needs and/or cash needs. However, farmers have long recognized that land cannot be used without limit and in this note, they have therefore experienced a decline in land productivity necessitating some actions on their part. According to Chomba (2004), in Onuoha (2010) the traditional redemptive action has been through land-fallow practices, clearing new land areas or crop rotation. However, with increasing land constraints in most areas, fallow periods have drastically declined. The traditional farming system that farmers have previously employed to sustain their productivity cannot any longer effectively work due to population pressure.

One of the biophysical constraints to increasing agricultural productivity is the low fertility of soils; and improving soil fertility levels has become an important issue in development agenda because of its linkage to food insecurity and economic wellbeing of the population (Ajayi, Akinnifesi, Sileshi, Chakeredza and Matakala, 2007 in Onuoha, 2010). Again, Onuoha, (2010) noted that sustained agricultural production in most sub-Saharan African countries is under threat due to declining soil fertility and loss of biomass. The smallholder farmers in these countries are quite aware of the declining trends in soil fertility, the reasons for this and its impact on yields and household food security. Many farmers also do know to some extent how to practice judicious management of their soils, using nutrients available in their vicinity and adopting agricultural practices geared towards soil fertility improvement such as improved fallow, agro-forestry and biomass transfer (Johansson, 2001 in Onuoha 2010).

Soil resource management efforts are crucial to the economic development of the rural dwellers that depend largely on land for livelihood. Therefore, the success of any soil conservation technique depends not only on the project planners' perception, but on the farmer's perception of its economic and environmental costs and benefits (Current, Lutz and Scherr, 1995 in Owombo and Idumah, 2015). However, despite the huge investments on soil conservation technologies by research and extension agencies in the country, there seems to be little empirical evidence on the adoption level of soil conservation technologies among smallholder farmers in Izzi Local Government Area, Ebonyi State. The specific objectives were to describe the socio-economic characteristics of smallholder farmers in the study area; identify and analyze available soil conservation technologies and their level of adoption in the study area; identify the sources of information on soil conservation technologies among smallholder farmers in the study area; ascertain the forms of soil degradation existing in the area, and coping strategies adopted by the smallholder farmers; determine the influence of socio-economic characteristics of smallholder farmers on the adoption of soil conservation technologies; and identify the constraints militating against smallholder farmers on adoption of soil conservation technologies in the study area.

II. Methodology

The study was carried out at Izzi Local Government Area of Ebonyi State. The Local Government Area is one of the thirteen (13) Local Government Areas of Ebonyi State. It is comprised of eight (8) Communities, namely; Agbaja, Ezza-Inyimagu, Igbeagu, Mgbalukwu, Ndieze, Ndieze-echi, and Ndiechiezza-Inyimagu. It is located in the north agricultural zone of Ebonyi State, with its Headquarter at Iboko. The study area has a land area of 1,069 km² with a total population of 236,679 people which comprised of 112,832 males and 123,847 females (NPC, 2006). The people of this area are mainly farmers, traders, craftsmen, carpenters, tailors, blacksmiths, while a few others are engaged in civil service jobs and politics.

Geographically, it is located within longitude 80.20'E and latitude 60.30'N on the world map. It is bounded by Abakaliki Local Government in the south, Ebonyi Local Government Area in the west as well as Ado Local Government Area of Benue State in the north and Yala Local Government Area of Cross River State in the East. Basically, the greater percentage of the people are farmers who practice mostly mixed type of cropping (Nwinya, Obienusi and Onuoha, 2014).

Fig 1: Map of Ebonyi State showing the Study Area

Sampling Technique

Multi-stage sampling technique was used for selection and sampling of respondents. This was done in the following stages: **Stage 1:** Four communities from the eight communities in the study area were randomly selected. **Stage 2:** Four (4) villages each were selected randomly from the four (4) communities making a total of sixteen villages that were used for the study. **Stage 3:** Ten (10) smallholder farmers were randomly selected from each of the sixteen (16) villages making a total of 160 respondents that was used for the study.

Data Collection and analysis

Primary data were collected using a structured questionnaire which was administered to 160 respondents in the study area as interview schedule. Relevant analytical techniques such as descriptive and inferential statistics were used to analyze the data. Descriptive statistics such as frequency counts, mean and percentage were used to achieve objectives i, ii and iii while objective **iv** was realized using mean scores derived from 4-point Likert scale. However, objective **v** was achieved using multiple regression analysis, while objective **vi** was realized using principal component factor analysis.

III. Result And Discussion

This section focused on the results and discussions of the findings of this study. Hence, the primary data collected from the field were analyzed and interpreted with the aid of appropriate statistical tools according to the specific objectives of the study.

Socio-Economic Characteristics of the Respondents

The socio-economic characteristics of the respondents considered were gender, age, educational level, marital status, household size, annual farm income, farm size, farming experience, method of land acquisition, member of farmer association and access to farm credit. The result of the socio-economic characteristics of the respondents was presented in Table 1.

Most (76%) of respondents were male, while few 24% were female. This showed that men were more involved in the adoption of soil conservation technologies than woman in the study area. This also shows that soil conservation practices in the area is dominated by men since the head of the household is the primary decision maker and men have more access to and control over vital production resources than women due to socio-cultural values and norms (Mesfin, 2005; Omonona, Oni and Uwagboe, 2006; Mignouna *et al*., 2011).

The age of most of the smallholder farmers (34%) ranged between 41-50 years while the least 8% ranged between 21-30years. About 28% were between 51-60years, while 14% and 16% were between 31-40

years and above 60 years respectively. The mean age of the respondents was 47 years. The mean age showed that most of the smallholder farmers in the study area are innovative and economically active in their agricultural undertaken as well as would be willing to accept the new technologies in agriculture. This corroborated with Arowolo, Abiona, Awotunde, and Olaoye (2013), who reported that farmers within the active age are highly innovative and could adopt soil conservation technologies easily compared to other aged farmers.

The result in Table 1 showed that the majority (94%) of the respondents were married; followed by 4% who were widowed. Others (1%, 1% and 1%) were single, widower and divorced, respectively. These showed that most of the smallholder farmers in the area were married. This is true because early marriage is culturally encouraged in the study area. In the same vein, family labour is easily sourced among married people as pointed out by Madukwe and Eze (2000) who reported that a high percentage of married smallholder farmers favoured provision of cheap family labour supply by members of the farm family. Similarly, married people play more active roles in rural development and technology adoption as they desire to enhance their production to meet their family responsibilities (Egwu, 2003).

In a traditional society, the size of household practically determines its labour. On this background, the result showed that 60% of the smallholder farmers have a household size of 6-10 persons; while very few (1%) lived with greater than 15 persons in their household and others (19%) and 19% had a household size of less than or equal to 5 and 11-15 persons, respectively. The average household size of the respondents in the study area was 8 persons. This entails that the household size of the respondents is large as most of them have realized the importance of labour force due to the economic situation of the country. Most rural households in the area relied more on family labour supply than hired labour to save money that would have been paid to hired labour. Many poorer households engage their members into hired labour to generate income for improvement of their family welfare. This is in line with the report of Nwobiala *et al.,* (2009) who reported that larger household size is a cheaper means of providing farm labour and reducing labour cost among the smallholder farmers.

The respondents' educational level of attainment was examined, and the result presented in Table 1 showed that 61% of the smallholder farmers had primary education; very few (3%) had no primary education where others, (22% and 14%) had secondary education and tertiary education respectively. However, the mean number of years spent in formal schooling by the respondents was 9 years. This entails that the smallholder farmers did not complete secondary education. This is abysmally low in view of the free education policy of Ebonyi State Government. This however, implied that some of the smallholder farmers in the study area were literates and would easily adopt soil conservation technologies more than their illiterate counterparts. This is in consonance with the observations of Onuekwusi, *et. al.,* (2014) who observed that increase in level of education increases the involvement of people (smallholder farmers) in development-oriented programmes and innovation adoption.

Result also showed that the farmers operated on an average farm size of 1.5 hectares. This implied that the respondents were mainly smallholder farmers who cultivated on less than 5 hectares of land which was the major characteristics of smallholder farmers. Again, the result also implied the fragmented nature of land holding due to the system of land ownership that encourages continuous fragmentation of land, which discourages commercial Agricultural practices. This was because two thirds of the rural population live on small farms less than two hectares, characterized by low technology, the use of family labour and subsistence orientations as reported by (Okoye, Okorji and Asumugha, 2004).

The result also showed that the farmers in the area had an average farming experience of 19 years. This showed that most of the smallholder farmers studied were experienced farmers. This also showed that the number of years a farmer spent in farming operations according to Umeh (2009) may give an indication of the practical knowledge he/she had acquired on how to overcome certain inherent farm problems. However, Yanko and Opara (2016) also reported that experience enables farmers to set a realistic goal and adopt innovations more readily than inexperienced farmers.

Results also revealed that farmers in the area had average farm income of ₦152,125 per annum. The result had shown that the income level of the respondents was moderate and could be attributed to good management of their soil resulting in an increase in their outputs/yields in the area. The moderate income of the respondents could translate to household welfare and great opportunity to technology adoptions. This was supported by Okello (2005) who reported that increase in income would enable poor households save more financial resources and consequently gain required financial ability to invest in technology adoption.

Results showed that the majority (93%) of the respondents had no access to farm credit; whereas few 7% had access. This implied that there was a low level of access to agricultural farm credit support among the respondents in the study area irrespective of its importance in agricultural production. This corroborated with Mary and Willy (2014) who reported that agricultural credit is productive and as well increases the level of adoption of soil conservation technologies, but its outreach is limited to a small proportion of the population.

The result showed that 64% of the respondents belonged to farmers' multi-purpose cooperative societies existing in the area, while 36% were not members of cooperative societies. These revealed that farmers

who belonged to one cooperative society or the other could pool their resources together and as such would be more innovative in their technology adoption. Again, most of the farmers who belonged to cooperative associations could access production inputs more easily than farmers who were not in any cooperative societies as well learn improved package of practices on agricultural production easily. This was supported by the view of Onu and Madueke (2002) who reported that meetings and associations created high levels of awareness of recommended technologies to smallholder farmers.

Available Soil Conservation Technologies and their level of Adoption in the study area

The available soil conservation technologies and their level of adoption were identified and analyzed in this section and result presented in Table 2.

The result in Table 2 showed that many (33%) of the respondents adopted Leaving crop residues in the field after harvest**;** while 28% of the respondents adopted intercropping practices and very few (7%) of the respondent adopted strip cropping. Further analysis revealed an adoption index of 2.21. The adoption index implied that the respondents in the study area use at least two (2) soil conservation technologies. This result further implied that the level of adoption of soil conservation technologies by the farmers to mitigate the loss of soil nutrients in Izzi farming system was inadequate considering the exacerbating and increasing environmental hazards that predispose their soil to nutrient loss. This finding is in line with the findings and assertion of pioneering and earlier studies (Frankenberger, 1990; Thomas, Cameron and Green 1989) whose work stated that despite the grievous negative consequences of the impacts of environmental factors on agricultural soil productivity in the developing countries, the level of adoption of soil conservation technologies were still inadequate.

Sources of information on soil conservation technologies among smallholder farmers in the study area

The sources of information on soil conservation technologies among smallholder farmers in the study area were identified and analyzed in this section.

Result in Table 3 showed that majority (54%) of the respondents sourced their information on soil conservation technologies through traditional sources which implied the use of indigenous source of information; followed by 49% of the farmers who sourced the information from fellow farmers and 48% who received information on soil conservation technologies through radio. However, others (38%, 29%, 26%, 11%,11% and 8%) sourced information on soil conservation technologies through newspaper, television, Ministry of Agriculture, ADP Extension agents, cooperative society and NGOs involved in Agriculture, respectively. The average source of information usage of the respondents was 2.72 showing that the respondents get information on soil conservation technologies in the study area from at least three (3) different sources. Hence, traditional knowledge plays a significant role in adoption of soil conservation technologies in the study area. This is in consistent with the findings of Simon *et al.,* (2012) who reported that the uptake of any technology, especially soil conservation technologies is often influenced by the farmer's contact with extension agent, friends, society members and the media.

Forms of soil degradation existing in the study area and coping strategies adopted by the smallholder farmers

The forms of soil degradation existing in the study area and coping strategies adopted by the smallholder farmers were analyzed using Mean Score Analysis derived from a 4-Point Likert Scale under the following sub-headings: Forms of soil degradation existing in the study area and Coping strategies adopted by the smallholder farmers. The results obtained were presented in Tables 4 and 5.

Result presented in Table 4 above showed that erosion, deforestation, reduced soil fertility and bush burning were the existing forms of soil degradation in the study area. This was because their scores were more than or equivalent to 2.5 derived from 4-Point Likert Scale for which decision was based for acceptance or rejection. Therefore, those that score below 2.5 were rejected as not forms of soil degradation existing in the study area. This result implied that soil erosion, deforestation and indiscriminate bush burning were the major threat to soil fertility in the area and hence called for adequate conservation measures. This was supported by the work of Edeh, (2008) who identified soil erosion, deforestation, bush burning, excessive flooding and overgrazing by farm animal as the major soil degrading agents in Southeast, Nigeria.

The results presented in Table 5 below showed that the most important coping strategies adopted by respondents in the study area were crop rotation, use of organic manure, intercropping practice, appropriate use of fertilizer, use of mixed cropping system and planting of trees. This was because they were accepted because their mean scores were equivalent or higher compared to the mean score (2.5) derived from the 4-Point Likert Scale in which decision were based. This implies that the smallholder farmers are aware of the soil degradation, thus their adoption of the coping strategies in the study area. From coping strategy index of 2.08, it was revealed

the farmers in the area used at least two (2) strategies to cope with the menace of soil degradation in the study area.

Influence of Socio-economic Characteristics of Smallholder Farmers on the Adoption of Soil Conservation Technologies

Ordinary Least Square (OLS) multiple regression analysis was employed to determine the influence of socio-economic characteristics of smallholder farmers on the level of adoption of soil conservation technologies in the study area. The dependent variable was level of technology adoption, while the independent variables were age, gender, educational level, marital status, household size, annual farm income, method of acquisition, farming experience, farm size, member of farmer association. Therefore, the results obtained were presented in Table 6.

The results of OLS multiple regression analysis in Table 6 showed that the coefficient of multiple determination (R^2) of the regression model was 0.760. This indicated that seventy-six percent (76%) of the sample variations in the dependent variable (level of technology adoption) were accounted for by the independent variables or explanatory variables (socio-economic characteristics of the smallholder farmers) included in the model. The f-ratio of 47.071 which was significant at 1% probability level showed that the coefficient of the explanatory variables included in the model were statistically different from zero, thus the goodness-of-fit of the model and its explanatory power.

From Table 6, it was observed that the age (-0.156) of the smallholder farmers was negatively significant at 5% level of probability. This implied that the age of the smallholder farmers was inversely related to the level of adoption of soil conservation technologies and as such the higher the age the lower the level of technology adoption, i.e. the older farmers were likely to be reluctant in their decisions to adopt new soil conservation technologies as they were risk averse. This agreed with the findings of Alufah *et al.,* (2012) who reported that the age of smallholder farmers was inversely related to the adoption of agricultural technologies. Similarly, the result was also supported by the findings of Wanyama, Mose, Rono, Masinde and Kariuki, (2010) and Simon, Garba, and Bunu, (2013) whose work reported that farmer's age and adoption of technologies were inversely related. Therefore, younger farmers would be more accommodative to new ideas and would invest in new and long-term soil conservation technologies. This also implied that a unit increase in the smallholder farmer's age would lead to 16% decrease in his propensity to adopt soil conservation technologies.

Result also showed that educational level (1.302) of the smallholder farmers was positively related to technology adoption at 1% level of probability. This implied that the adoption of soil conservation technologies in Izzi Local Government Area was positively and greatly influenced by educational level of the smallholder farmers in that it enhanced the ability to obtain, process, adopt new technologies and thus increased the ability of the smallholder farmers to use their resources efficiently. This was in consonance with the work of Odoemelam and Olojede, (2016) who reported that as one's level of education increases the less conservative and more inquisitive he/she becomes wanting to know virtually everything around him or that is connected to his survival that would either increase his production or make him exceptional to other uneducated conservative illiterate young farmers.

From Table 6, it was discovered that household size (-0.229) of the smallholder farmers had a negative relationship with the level of adoption of soil conservation technologies. The negative coefficient indicated that a unit increase in household size would translate to a 23% decrease in the level of adoption of soil conservation technologies in the study area. This is consistent with the work of Bekele and Mekonnen, (2010) who reported that a large household size working in the farm, though reduces the farm's external labour requirements but is inversely influenced the level of adoption of soil conservation technologies.

Result also indicated that Farming experience (0.795) was positive and significantly related to the level of soil technology adoption at 1% level of significance. This implied that the experience of the smallholder farmers had a significant influence on the level of adoption of soil conservation technologies in the area. This also indicated that farming experience would improve their skills in the use of soil conservation technologies. However, this agreed with Owombo and Idumah, (2015) who reported that farmers with higher experience appear to have often full information and better knowledge and can evaluate the advantage of the technology.

The coefficient of farm size (0.494) was found to be positive and statistically significant at 5% level of probability. This showed that a little increase in size of farmland would result in an increase in the adoption of soil conservation technologies in the study. This indicated that increase in farm size would imply moving towards commercialized farming, which entails more investment on soil conservation technologies. This in line with the work of Akpan *et al.,* (2014) who reported that increase in farm size would lead to increase in the adoption of soil conservation technologies as operators should have more flexibility in their decision making, greater access to discretionary resources, more opportunity to use new practices on trial basis and more ability to deal with risk

The membership of farmer association of the smallholder farmers had a positive relationship and highly significant at 1% level of probability with the level of technology adoption for soil conservation. This implied that increased interactions among smallholder farmers and between farmers and other social associations or groups increases awareness, knowledge and sharing of facts concerning farming activities in relation to adoption of soil conservation technologies. This enhances or influences adoption or the use of improved soil conservation technologies. This work is in tandem with the research report of Wollin and Anderson (2014) who reported that membership of a group or association increases the likelihood to adopt soil conservation technologies in the area as well as enhances the interaction and exchange of ideas among the group.

Constraints militating against smallholder farmers on Adoption of Soil Conservation Technologies in the Study Area

The principal component method of factor analysis was used to identify constraints militating against smallholder farmers' adoption of soil conservation technologies in the study area and the results were presented in Table 7.

From the result of the varimax principal component factor analysis and the Kaiser's rule of thumb of 0.400 loading of variables, it was observed that the constraint to the adoption of soil conservation technologies were of social, institutional and economic factors. Specifically, the constraining variables in the social factors include non-availability of suitable implements (0.686), soil conservation technologies require high management skills (0.684), high transport cost (0.532), inadequate credit to obtain the technology (0.635), and poor road infrastructure (0.581). On the other hand, the variables that loaded high for institutional factors include insecure land tenure system (0.789), non-availability of technology (0.693), and lack of training for farmers wishing to use technology (0.528). Finally, the variables that loaded high for economic constraints were technologies are costly to use and sustain (0.711), inadequate and high cost of labour **(**0.426), competitive use of crop residues **(**0.630), and poor returns from farms **(**0.446).

Access to credit is a very important factor influencing the adoption of agricultural technology by the smallholder farmers. Credit could facilitate farm households to purchase the needed agricultural inputs and enhance their capacity to effect long-term investment in their farms, especially investment in soil conservation technologies. This was supported by the findings of Kassie, *et al.,* (2013) who reported that access to rural credit and savings plays an important role in diffusion and adoption role of soil conservation technologies as well as facilitates purchase of inputs for the adoption of soil conservation technologies.

Adequate feeder roads are always necessary for proper evacuation of agricultural products from the point of production to places of ultimate consumption or to places of value addition. This would go a long way towards the improvement of the standard of living of the rural farmers as well as their social status. On the contrary, poor road infrastructure had hindered the development of agriculture as well as the adoption of soil conservation technology and investments since farm produce are sold at farm gate prices. The translated to the poor diffusion and adoption of agricultural technologies especially soil conservation technologies.

Increase in population growth has exacted pressure on the existing resources especially land thus the insecure nature of tenure system and hence a problem to the adoption of soil conservation technologies. Contrarily, secure land tenure has been widely demonstrated to play a critical role in influencing farmers' willingness to invest in soil conservation practices. This is in line with findings of Kassie, *et al.,* (2013) and Teshome *et al.,* (2014) who reported that land tenure security is related to investment on land thus a positive relationship exists between secure land tenure and investment on soil conservation technology. They further reported that 'assurance effect' of secure land tenure provides a guarantee to farmers to invest in both short and long-term soil management practices

Household's labour availability is expected to positively affect the farm household's decision to adopt soil conservation technology since soil conservation is claimed to be labour intensive and therefore, smallholder farm households with sufficient labour are expected to be in a better position to adopt the conservation technologies

Residue management is a conservation practice that is designed to leave crop residue on the soil surface to prevent erosion. The amount of residue on the soil surface depends on the amount of residue left from the previous crop and the tillage performed. Considering other uses of crop residues and the need for soil fertility replenishment and erosion control, crop residue is therefore multipurpose and competitive in usage hence the challenge of soil conservation.

The technological options are less available in developing countries like Nigeria to relieve humans. As result farm execution of most farm-related activities require human labour which is scarce and as such costly. The construction and maintenance of physical soil conservation technologies structures require intensive human labour for which machinery has not been developed or introduced in most developing countries. The non-availability of labour-saving devices had increased the cost of labour and also a problem to the adoption of soil

conservation technology. This was supported by the findings of *Ashoori et al*., (2016) who reported that lack of labour-saving devices had increased the cost of labour and a reduction in the level of soil conservation technology adoption.

IV. Conclusion

This study had shown that socio-economic characteristics of the smallholder farmers were the determinants of adoption of soil conservation technologies in Izzi Local Government Area Ebonyi State, Nigeria. That level of adoption of soil conservation technologies was influenced by their age, household, educational level, farming experience, farm size and membership of farmer association. The smallholder farmers were hindered by social, institutional and economic constraints as they pushed forward in conserving their soil.

Table 1: Distribution of the socio-economic characteristics of the respondents

Socio-economic variables	Category	Frequency (N=160)	Percentage	Mean ($\bar{X}$)
Sex	Male	121	76	
	Female	39	24	
Age (yrs)	21-30	12	8	
	31-40	23	14	
	41-50	55	34	47
	51-60	44	28	
	Above 60	26	16	
Marital status	Single	1	0.6	
	Married	150	94	
	Divorced	1	0.6	
	Widowed	6	4	
	Widower	2	1	
Household size	≤ 5	31	19.4	
	6-10	96	60	8
	11-15	31	19.4	
	> 15	2	1.3	
Education (years)	No Formal Education	5	3	
	Primary Education	98	61	9
	Secondary Education	35	22	
	Tertiary Education	22	14	
Annual Farm Income	≤ ₦50,000 - ₦100,000	63	39.4	
	₦101,000 - ₦150,000	50	31.3	
	₦151,000 - ₦200,000	35	21.9	₦152,125
	₦201,000 - ₦250,000	9	5.6	
	₦251,000 - ₦300,000	1	0.6	
	Above ₦400,000	2	1.3	
Farm Size (Ha)	≤ 0.5ha	16	10	
	0.6-1.0ha	40	25	
	1.1-1.5ha	54	33.8	1.5
	1.6-2.0ha	31	19.4	
	2.1-2.5ha	18	11.3	
	2.6-30ha	1	0.6	
Farming Experience (Years)	≤ 5	7	4.4	
	6 - 10	19	11.9	
	11-15	36	22.5	19
	16 -20	37	23.1	
	21- 25	28	17.5	
	26 – 30	20	12.5	
	Above 30	13	8.1	
Access to farm credit	Yes	11	6.9	
	No	149	93.1	
Membership of farmer association	Yes	102	63.7	
	No	58	36.3	

Source: **Field Survey, 2024**

Table 2: Distribution of Available Soil Conservation Technologies and their level of Adoption in the study area

S/N	Technologies	Frequency (N=160)	Percentage (%)
1.	Agro-Forestry	17	10.6
2.	Crop Rotation	41	25.6
3.	Green manure	13	8.1
4.	Shifting cultivation	28	17.5
5.	Intercropping	45	28.1
6.	Leaving crop residues in the field after harvest	52	32.5
7.	Minimum or zero tillage practice	38	23.8
8.	Mulching	31	19.4
9.	Planting cover crops	22	13.8
10.	Planting tree	20	12.5
11.	Strip cropping	11	6.9
12.	Use of compost manure	14	8.8
13.	Use of livestock manure	22	13.8
	Mean score (mean of technologies adopted)	**2.21**	

Source: Field Survey, 2024;

Table 3: Distribution of sources of information on soil Conservation Technologies among Smallholder Farmers in the study area

S/N	Sources of information	Frequency (N=160)	Percentage (%)
1.	Traditional source	86	53.8
2.	Ministry of Agriculture	41	25.6
3.	ADP Extension agents	18	11.3
4.	Fellow farmers	79	49.4
5.	NGOs involved in Agriculture	12	7.5
6.	Cooperative society	17	10.6
7.	Radio	76	47.5
8.	Television	46	28.8
9.	Newspaper	60	37.5
Mean score (mean of source of information usage)		**2.72**	

Source: Field survey, 2024; Multiple Responses Recorded

Table 4: Forms of soil degradation existing in the study area

Forms of soil degradation	Mean score	Decision
Erosion	2.58	Accepted
Deforestation	2.51	Accepted
Reduced soil fertility	2.51	Accepted
Flood	0.81	Rejected
Loss of soil cover	1.31	Rejected
Increased surface runoff	1.81	Rejected
Bush burning	2.59	Accepted

Source: Field survey, 2024

Table 5 Coping strategies adopted by the smallholder farmers in the study area

Coping strategies adopted	Mean score	Decision
Shifting cultivation	2.22	Rejected
Crop rotation	2.58	Accepted
Use of organic manure	2.46	Accepted
Intercropping practices	2.46	Accepted
Appropriate use of fertilizer	2.48	Accepted
Bush fallowing	1.01	Rejected
Avoidance of bush burning	1.47	Rejected
Use of mixed cropping system	2.59	Accepted
constructing drainage and water channels	2.27	Rejected
Minimum or Zero tillage	1.11	Rejected
Use of mulching	1.77	Rejected
Planting of trees	2.51	Accepted
Average Total Mean Score (coping strategy index)	**2.08**	

Source: Field Survey, 2024

Table 6: OLS Multiple Regression Analysis on the Influence of Socio-economic Characteristics of Smallholder Farmers on the Adoption of Soil Conservation Technologies

S/N	Variables	Coefficients	Standard errors	t-value
X_1	Age	-0.156	0.049	-3.214**

X_2	Gender	-0.467	0.903	-0.517 ^{ns}
X_3	Educational level	1.302	0.114	11.421***
X_4	Marital status	1.134	1.356	0.836 ^{ns}
X_5	Household size	-0.229	0.039	-5.872***
X_6	Annual farm income	0.008	0.016	0.130 ^{ns}
X_7	Method of acquisition	1.534	2.292	0.669^{ns}
X_8	Farming experience	0.795	0.068	11.631***
X_9	Farm size	0.494	0.115	4.296**
X_{10}	Member of farmer association	0.773	0.221	3.498***
	Constant	7.495	0.566	13.242***
	F-ratio	47.071***		
	R^2	0.760		
	Adjusted R^2	0.743		

Source: Field Survey, 2024; *** & ** significant at 1% & 5%, respectively; **ns**=not significant

Table 7: Varimax Rotated Component Matrix on Constraints militating against Smallholder farmers on Adoption of Soil Conservation Technologies in the study area

Variables names	Social constraints	Institutional constraints	Economic constraints
Insecure land tenure system	0.081	0.789	-0.102
Technologies are costly to use and sustain	0.227	0.125	0.711
Inadequate and high cost of labour	0.042	0.050	0.426
Non-availability of suitable implements	0.686	0.083	-0.107
Soil conservation technologies require high management skills	0.684	-0.199	-0.133
Inadequate information about technology	-0.078	-0.287	0.240
Non-availability of technology	-0.185	0.693	-0.056
Our culture and tradition forbids its use	0.054	-0.117	-0.024
Competitive use of crop residues	0.261	0.164	0.630
High transport cost	0.532	-0.001	0.073
Lack of extension support	0.126	-0.021	-0.186
Inadequate credit to obtain the technology	0.635	-0.076	-0.087
Poor road infrastructure	0.581	0.276	0.043
Lack of trainings for farmers wishing to use technology	0.316	0.528	0.219
Poor returns from farms	0.301	0.134	0.446

Source: Field Survey, 2024

V. Recommendations

Based on the findings of the study, the following recommendations were made: Agricultural extension agents who are saddled with the responsibility of disseminating timely, complete actionable information should be repositioned and strengthened to ensure smallholder farmers access to information, through appropriate channels and to shift the balance between success and failure of the smallholder farmers.

Developers of new agricultural technology should try to understand the farmers' needs as well as their ability to adopt technology to develop technology that will suit them. Exogenous supports such as provision of credit facility to smallholder farmers would enhance the adoption of soil conservation technologies among the smallholder farmers. Improved availability of information to smallholder farmers and other farmers from within and outside the study area will enable them to explore opportunities for using soil conservation technologies that will improve their productivity and livelihoods.

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