ASSESSMENT OF CEREAL CROP FARMERS' ADAPTATION STRATEGIES TO LAND DEGRADATION IN RURAL AREAS OF NIGER STATE, NIGERIA

BY

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M.Tech/SAAT/2018/7851

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY IN AGRICULTURAL EXTENSION AND RURAL DEVELOPMENT

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ABSTRACT

The study assessed cereal crop farmers' adaptation strategies to land degradation in rural areas of Niger State. Three-stage sampling technique was employed to select 227 respondents for the study on which primary data were elicited from the respondents with the aid of a semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive statistics (such as frequency, percentage and mean), inferential statistics (Poisson regression and Pearson product moment correlation). The results obtained showed that majority (84.1%) of cereal crop farmers in the study area had experienced one form of soil degradation or the other. The study revealed that run-off (89.8%), waterlogged (78.9%) and soil structure destruction (75.3%) ranked 1st, 2nd and 3rd respectively were the physical land degradation experienced by cereal crop farmers, while low nutrient availability (96.5%) and increase soil acidity (72.1%) ranked 1st and 2nd were the major chemical land degradation experienced by the cereal crop farmers in the study area. Furthermore, soil nutrients loss ($\overline{X}$=4.5) ranked 1st , occurrence of soil erosion and reduction of crop yield ($\overline{X}$=4.3) ranked 2nd were land degradation that had top most effect on the output of cereal crop farmers. The study further revealed that majority (87.2%) of the respondents adopted terracing to reduce the menace of land degradation which ranked 1st. Moreso, the study revealed that terracing ($\bar{X}$=4.5) ranked 1st is the most effective adaptive strategies on land degradation. The study further showed that Poison regression estimate on the factor influencing the choice of adaptation strategies to land degradation in the study area revealed that coefficient for level of education (.0926) was positive and statistically significant at 0.01 probability level, coefficient for training received (.0950) was positive and statistically significant at 0.10 probability level, coefficient for extension contact (.0440) was positive and statistically significant at 0.10 probability level, coefficient for access to credit (.1066) was positive and statistically significant at 0.01 probability level, crop output (.0012) was positive and statistically significant at 0.05 probability level, coefficient for sex (.0220) was positive and statistically significant at 0.01 probability level and coefficient for goal of farming (.0500) was positive and statistically significant at 0.05 probability level. The study further revealed that most of the selected socio-economic variables play significant roles in the choice of adaptation strategies to mitigate the effects of land degradation. The study recommended that cereal crop farmers should be sensitized by relevant stakeholders (Governmental and Non-Governmental Organization) on the effects of their activities on the land which deplete soil nutrients and train on the best coping strategies for natural occurrences like flood.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Land degradation is a global phenomenon that alters the production function and sustainability of agriculture and induced farmers to convert farmland into lower-value uses. The main effect of land degradation is reduction in the productivity of agricultural output. Factors such as deforestation, unsustainable use of natural resources, cultivation of marginal lands, unprecedented growth of human and livestock population contributes to farmland degradation (Amenu and Birhanu, 2018).

Land degradation is a menace to the future generation and entire human existence. Onyerika (2016) posited that land degradation is a major aspect of environmental degradation, its various forms include; soil erosion, land pollution, flooding, bush burning, improper waste disposal, deforestation, compaction and hard setting of soil. The resultant consequences of land degradation are; washing away of soil nutrients/particles, exposures of sub soil surfaces, exposure of roots of plants/trees and foundation of buildings, poor vegetative growth and low levels of crop yield as well as total crop failure. Increase cultivation resulting in the opening up of new lands exposes the top soil to the elements of degradation and alters the natural ecological conservatory balances in the landscape (Senjobi and Ogunkunle, 2010).

Adewuyi *et al.* (2019) refers to land degradation as “a persistent net loss of capacity to yield provisioning, regulating and supporting ecosystem services”, thus, a reduction in Net Primary Productivity (NPP). According to Busari (2010), land degradation is the process of decay in the land’s physical and biological resources, which continues until it reduces the land’s value. The economic prosperity of most developing countries, including Nigeria, however, revolves essentially around the exploitation and use of land resources particularly in the primary industry such as agriculture (Akinnagbe and Umukoro, 2011). It was observed that the available land if not justifiably utilized can barely provide sufficient livelihood support to the current users, let alone carrying significant potential for the survival of the future generations (Adewuyi and Mustapha, 2017).

There is the need to question the sustainability of the current trend of land utilization in the short, medium and long-term effects and to devise means of restoring the land to cater for both the current and future generations. The report of United Nations Convention to Combat Land Degradation (UNCCD) stated that land degradation results in severe soil fertility depletion and productivity decline, shrinking crop yield and ecological damages including erosion loss, leaching, water run-off, flood and gullies which are some of the adverse effects from uncontrollable land use and agricultural intensification.

Land degradation, which results to a decline in land quality caused by human activities will remain high if not checked. In the developing countries like Nigeria where a large percentage of human population depends almost totally on land resources for their sustenance, there is increasing demand for land utilization such as grazing, fish pond construction, quarrying and crop farming amongst others (Akinnagbe and Umukoro, 2011). The drive towards safeguarding food security should be channeled towards developing agricultural practices and system that will be environmental responsive and also focus on productivity on the long term rather than immediate production and ensuing returns (Bankole *et al.*, 2012).

According to Akinnagbe and Umukoro (2011), land degradation assumes varying dimensions depending on one's location. In Nigeria, for example, residents of the coastal areas are not as worried by the fear of desert encroachment as those who reside in Borno, Sokoto, Katsina and Kano States of the country. Just as they worry about oil pollution and spillage, coastal erosion and flooding in Niger Delta areas. Sheet erosion is nation-wide while gully erosion is most severe and dense in certain Southern States like Anambra, Imo, Abia, Enugu, Ondo, Delta and Akwa Ibom. Flooding occurs in almost all States of Nigeria.

Many people also depend on the land to build their houses, while construction companies equally excavate the top soil for various infrastructural development. All these socio-economic activities are known to often have negative impact on the condition of the soil, vegetation and water resources (Adewuyi *et al*., 2017). When the impact is negative and continuous over a long period of time, it results into land degradation of different forms. However, to achieve a sustainable growth and development in agriculture, land which is a major factor of production must be given proper attention (Onyerika, 2016).

Growing food crops, such as cereals, to keep pace with the population demand while retaining the quality of land and the ecological balance of the production system, is a current challenge to agricultural research and policy in Nigeria. Increase in world population and other non-agricultural land use are putting extra pressure on land hence there is increasingly less land for food production due to degradation as demand for food and other agricultural products keeps increasing. Increasing food production to keep pace with growing population require more land which is not available due to degraded arable land area (Onyerika., 2016). The rapidly expanding population and its consequent pressure on land for socio-economic, agricultural and industrial development had significant effect on food crops production in the study area especially cereal crops (Bifarin *et al.*, 2013).

1.2 Statement of the Research Problem

Evidence suggest that factors such as agricultural pastoralism, fire-wood extraction or lumbering activities, agricultural expansion/intensification and climatic factors such as flood, rainfall variability, and increasing population are the major causes of land degradation. Under investment in land which includes the dilapidation of existing mechanisms that are not maintained such as terrace, irrigation works, and drainage systems are also key issues which needs serious attention because water as we know will always find its level if not properly channeled, thereby degrading the land, which may pose serious threat to cereal crop production in Niger state.

Land degradation, no matter the form or extent, is inimical to the socio-economic development of any area because it reduces the productivity of the land which subsequently reduces the income and standard of living of farmers. Some of the recent challenges faced by residents of the areas affected by land degradation are reduction in crop yield, reduction in size of land available for agriculture (crop farming and animal husbandry), limited land use options, increase in cost of conservation, forceful migration, hostility and poverty (Adewuyi *et al*., 2019). It is important for a country with a growing population of more than 200 million people (National Population Census, 2006) to conserve its soil in order to meet up with the challenges of food insecurity and to educate its farmers on the different combination of appropriate land use and management practices that promotes productive and sustainable use of soils which in turn minimizes soil erosion and other forms of land degradation.

The aim of land conservation is to ensure sustainable land management practices that will not only reduce land degradation to the barest minimum, but also maintain maximum residues cover for protecting land against erosion and increasing water infiltrations without reducing crop yield to meet up with the rising demand for food and ensuring sustainable food security. Apart from the physical and climatic causes of land degradation, there are some social and economic factors behind the problem of land degradation that have often been neglected in many technical studies

In recent years, several modern approaches to control land degradation (soil erosion) for enhanced agricultural production and development have failed due to lack of knowledge and perception of farmers who are into various agricultural production (Adewuyi *et al*., 2019). Farming is the main occupation of the people in the study area, thus issues related to land degradation cannot be over emphasized. These farmers have little or no information on the extent to which land degradation can affect their productivity and output level which constitutes a gap in knowledge hence the need to carry out this study which assess cereal crop farmers adaptation strategies to land degradation in rural areas of Niger State. In view of the above, the study attempt to provide answers to the following research questions;

i. What are the socio-economic characteristics of the respondent in the study area?
ii. What are the forms of land degradation experienced by the respondents?
iii. What are the perceived effects of land degradation on cereal crop production by the respondents?
iv. What are the adaptation strategies adopted to mitigate the effects of land degradation?
v. What is the perception of farmers on effectiveness of the adaptation strategies?
vi. What are the factors influencing the choice of adaptation strategies by the respondents?

1.3 Aim and Objectives of the Study

The aim of the study was to assess cereal crop farmers adaptation strategies to land degradation in rural areas of Niger State.

The specific objectives were to:

i. describe the socio-economic characteristics of the respondents in the study area;

ii. identify the forms of land degradation cases experienced by the respondents;

iii. assess the perceived effects of land degradation on cereal crop production output;

iv. examine the adaptation strategies adopted to mitigate the effects of land degradation;

v. assess the effectiveness of the adaptation strategies adopted to mitigate land degradation by the respondents, and

vi. determine the factors that influence the choice of adaptation strategies adopted to mitigate land degradation by the respondents in the study area.

1.4 Hypotheses of the Study

HO_1: There is no significant relationship between selected socio-economic characteristics of the respondents and their choice of adaptation strategies adopted to mitigate the effects of land degradation in the study area.

HO_2: There is no significant relationship between the perceived effects of land degradation on cereal crop production and effectiveness of the adaptation strategies adopted to mitigate effects of land degradation in the study area.

1.5 Justification of the Study

Agriculture is a very important sector in most developing countries like Nigeria, it plays significant roles in the country's economy. Land degradation which forms the bases for this study has consequences which are mostly felt by farmers. Nigeria has a population who are mostly farmers and are rural dwellers, therefore understanding the types of land degradation which are prevalent in our communities and their causes will help government in tackling this menace. Assessing the effect of land degradation on cereal crop production will help research institutes in developing more viable seeds which can withstand some of the effects of land degradation, which will in turn increase cereal crop production.

The study examines the control measures to land degradation which were adopted by farmers and also examine its effectiveness, so as to suggest better land management practice to the farmers and also proffer possible solutions to the menace by incorporating old and new ideas on how land degradation can be effectively managed. Local societies who are affected by land degradation rarely partake in science-led approaches, or derive results that can improve the sustainability of their land management. Therefore, there is the need to incorporate indigenous knowledge on land use among farmers on planning and management so that communities are able to fully realize their capacity to adapt to the challenges of land degradation.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Socio- Economic Characteristic of Famers in the Study Area

2.1.1 Age of farmers

Age is a very important factor affecting crop production, it also increases farmer's knowledge of their environment and the effects of land degradation on crop production in Nigeria. Akinnagbe and Umukoro (2011) revealed that greater proportion (43.4%) of the farmers were between the age range of 51 and 60 years, the average age of the respondents was 54 years. This implies that the farmers are experienced, hence they have acquired enough farming experience needed to perceive the effects of land degradation on farming activities in their area, over the years. The average year of the respondents is an indication that majority of them may have lived above 50 years which made them to have basic knowledge about the environmental problems in their area. Ogunjinmi *et al.* (2017) reported a positive and significant relationships existed between farmers' perceptions of Environment-Friendly Farming Practices (EFFPs) and age of the respondents, They suggested that the older the farmers, the increase in their perceptions of EFFPs, which could probably be as a result of experiences acquired on EFFPs over time. Similarly, Gido *et al.* (2013) also asserted that age had positive relationship with organic soil management practices.

2.1.2 Marital status of the farmers

Marital status has a significant role to play on the household labour availability. The common cultural practice of early marriage and labour demand among farming households in the rural areas explains this development. According to Austin and Nahanga (2017), 61% of the respondents are married. Ali *et al.* (2018) reported that due to the early age at which people got married in northern Nigeria, over 96.8% are married.

This is important because it brings about multiplication and expansion of the household which may serve as a source of labour for the family.

2.1.3 Educational level of farmers

Education is a precondition for improving agriculture and consequently the living standard of the rural dwellers, education has promoted development and means for harnessing the potentials of farmers (FAO, 2014). Gido *et al*. (2013) reported that formal education of household heads is positively correlated with perceptions towards organic soil management practices. Similarly, Tesfaye (2018) reported that levels of education significantly and positively determined farmers' perception of the risk of decline in agricultural land productivity due to land degradation and soil erosion. Hence, older household heads were less likely to perceive the effects of erosion. While younger farmers were more prone to perceive erosion cases in their farms, the author further asserted that, this may be due to greater education, higher access to information and a longer planning horizon, or simply the fact that older farmers might have grown accustomed to soil erosion, considering it a normal process.

Farmers with higher level of formal educational attainment were most likely to perceive land degradation risk in their plots as compared with less educated farmers with other factors held constant. Possible explanation offered is that educated farmers tend to have better access to research output reports and generally to update information about the risks associated with land degradation and soil erosion, and hence, tend to spend more time and money on soil conservation. This is because literate farmers often serve as contact farmers for extension agents in disseminating information about agricultural technologies from government agencies (Gido *et al*., 2013).

2.1.4 Farming experience of farmers

The higher the age of the respondents, the higher their experience in farming and this translates to more encounter with risks among older farmers than in younger farmers (Ogunmefun and Achike, 2015). Farming experience is expected to help farmers in boosting crop production through the knowledge acquired from years of farming. Akinnagbe and Umukoro (2011) reported that majority of the farmers had been in farming business for more than 21 years, while others had between 16 and 20 years of farming experience respectively. From the study, the average years of farming experience was about 19 years. This implies that, the respondents are experienced farmers; and might have acquired enough farming experience needed to perceive the effects of land degradation on farming activities in their area, over the years.

2.1.5 Extension contact by farmers

Swanson (2008) stated that the term agricultural extension was no longer restricted to the emphasis on technology transfer reflected by the Training and Visit System but has moved towards broader concepts which included developing the skills and management capacities of farming families. Many factors influence the small - scale farmers in a bid to enhance their standard of living through increased food production. Agricultural extension is basically designed to remove obstacles that are likely to inhibit increase food production among farm families. Apart from cash donations by international development agencies, extension workers were also mobilized to educate farmers on the control of farm land degradation (Ovwigho, 2014). He further opined that agricultural extension helped to get the farmers into a frame of mind and attitude conducive to acceptance of new technology such as land management practices. Ovwigho (2014) reported that there was a positive and significant relationship between extension contact and perception of the effects of farm land degradation on yam production. The study revealed that majority

(90%) of the yam farmers got their information on land degradation through agricultural extension agents. In a related study conducted by Tesfahunegn *et al.* (2021) indicated that the most determinant six variables for farmers to perceive soil erosion were age, education, farming experience, total farmland size, farmland slope, and access to extension services. This could be attributed to the fact that access to extension services such as training, knowledge and technology sharing opportunities can enhance farmers' perception to look for options of land degradation mitigation strategies.

2.1.6 Access to credit

Access to credit which is the ability of household to obtain credit both in cash and kind for either consumption or to support production, increase household income in the short run and could increase the consumption basket of household (Omotosho and Sholatan 2007). Production credit when obtained on time could increase chances of household to acquire productive resources (seeds, seedlings, fertilizers, pesticides and others) which will boost and improve crop production.

2.1.7 Farm size of farmers

Tesfaye (2018), reported that farm holding size was also important factors to determine the effects of soil and water conservation (SWC) practices. The larger the farm holding size, the higher is the likelihood of witnessing rills, surface runoff, sediment deposition and redeposition by farmers. Akinnagbe and Umukoro (2011) revealed that majority (96.6%) of the farmers had less than 2 hectares while only 3.4% had between 2.1 and 4 hectares of land for farming. The average farm size was 1.2 hectares. This shows that they are small scale farmers, which is a typical feature of rural farmers in Nigeria. Larger parcel size may create a positive incentive for small-scale farmers to invest in SWC technologies (Tesfaye *et al.,* 2014; Teshome *et al.,* 2016).

2.1.8 Household size of farmers

The household is the main source of labour for production activities in the forest areas. Among family members, individual provide labour under reciprocal arrangements during land preparation and harvesting. Labour is also provided to other non-family members for a fee and is a good source of income for the households. Often most rural household depend on hired labour for land preparation and sustainable soil management (David, 1997). The potential in this kind of labour arrangement is that it brings people together and could enhance the sharing of knowledge and collective action to adopt improved sustainable forest practices as was noted by Nyangena (2008). The largeness of the farmers' family could reduce the demand for hired labour, as members of the farm families could carry out some of the farming and non-farming activities. (Akinnagbe and Umukoro, 2011).

2.2 Concept Definition and Conceptual Framework

2.2.1 Concept of land degradation

Land degradation is a global phenomenon that mostly affects societies at the local level where rural communities closely related to land resources are vulnerable. Land degradation can be described as an environmental phenomenon affecting dry lands, a long-term decline in ecosystem function and productivity (Barman *et al.*, 2013). The main outcome of land degradation is reduction in the productivity of agricultural output (Amenu and Birhanu, 2018). Soil erosion is a root cause of land degradation and the most dangerous ecological process in Nigeria, Land degradation is a complex phenomenon influenced by natural and socio-economic factors. In many economic analyses, there is a tendency to attribute soil fertility decline only to soil erosion. Erosion was treated as the sole contributing factor to soil/land degradation and yield declines, as the impacts of nutrient depletion on crop yields were underestimated or completely neglected (Sisay, 2018).

Land degradation in Africa, like elsewhere in the world, can be traced to human activities and is therefore, amongst others, related to the issue of human population pressure. Over the past four to five decades, ever growing human and animal populations have increasingly become a threat to agriculture and livestock practices all over Africa, and particularly the sub-Sahara continent which have consequently resulted to over-cultivation and over-grazing, hence, reduction in the productivity of land. The widespread destruction of tree and vegetation cover for fuel wood (encouraged by the high prices of petroleum-based fuel) and for construction has accelerated the process of land degradation. Poor water management and salinization of irrigation systems have also left their mark. The over-use and mismanagement of natural resources, and more particularly of the land and its resources have resulted in soil erosion and desertification. These consequently leads to the deterioration of the soil base which again threatens the regions natural capital (Sisay, 2018). Land degradation is, usually, the result of complex inter-relationships between biophysical and socio-economic issues which affect many people and their land, especially in the tropics and developing countries. The term land degradation involves both soil and vegetation degradation. Soil degradation refers to negative changes in the physical, chemical, and biological properties of the soil, whereas vegetation degradation is the reduction in the number of species and the vegetational composition.

Usually, land degradation is described in terms of the loss in natural resources (soil, water, fauna and flora) or in the biophysical process by which it functions**.** Soil can be eroded, salinized or impoverished. Water can be lost through evapotranspiration, evaporation, infiltration, run-off, pollution, or overuse. As habitats diminish, so also do the abundance, uniqueness and diversity of living things (Abdi *et al.*, 2013).

2.2.2 Types of land degradation

Land Degradation can be categorized into two different types namely: Physical degradation and Chemical degradation

2.2.2.1 *Physical degradation*

Physical degradation of soil involves the destruction of soil structure, dispersion of soil particles, sealing of pores, compression and increasing density, consolidation, compaction and reduced root penetration, low infiltration, waterlogging and runoff, and accelerated erosion. Along with denudation, these processes lead to desertification in the arid and semiarid regions. Physical degradation leads to massive soil loss, and may occur as a result of elements of nature such as wind, rain or earth movements like earthquakes. But it is also often caused by man's activities like excavation and felling of trees. Crop productivity in physically degraded soils can become virtually impossible. Two common types of physical degradation are erosion and desertification (Onyerika, 2016).

Soil erosion is a natural process that removes soil from the land by the forces of water and wind. The eroded particles are transported by wind and water to some other location, where it is deposited as sediment. Erosion is a global problem, and since topsoil production rates are so slow, the lost top soil is essentially irreplaceable. According to Onyerika (2016), most of the cause of land degradation worldwide is soil erosion, of different forms namely sheet erosion (a more or less uniform removal of a thin layer of topsoil), rill erosion (small channels in the field) and gully erosion (large channels, similar to incised rivers).

Sheet erosion is the movement of soil from raindrop splash and runoff water. It typically occurs evenly over a uniform slope and goes unnoticed until most of the productive topsoil has been lost. Deposition of the eroded soil occurs at the bottom of the slope or in low areas. Lighter-coloured soils on knolls, changes in soil horizon thickness and low crop yields on shoulder slopes and knolls are other indicators (Balasubramanian, 2017). Gully erosion remains the most rampant in Southeast Nigeria, and this form of land degradation has been aggravated by constant land excavation for building constructions, Gully erosion is "the removal of soil or soft rock material by water, forming distinct narrow channels, larger than rills, which usually carry water only during and immediately after rains". Gully erosion is an advanced stage of rill erosion.

A gully is a distinct channel, carved into a hills lope or valley bottom by intermittent or ephemeral runoff. Such channels are carved where the force exerted by flowing water – a function of its mass and velocity – exceeds the subsoil's resistance. Gully erosion results in significant amounts of land being taken out of production and creates hazardous conditions for the operators of farm machinery (Balasubramanian, 2017).

Rill erosion is the removal of soil by concentrated water running through little streamlets, or head cuts. Detachment in a rill erosion occurs if the sediment in the flow is below the amount the load can transport and if the flow exceeds the soil's resistance to detachment. As detachment continues or flow increases, rills will become wider and deeper. Rill erosion mainly occurs as a result of concentrated overland flow of water leading to the development of small well-defined channels. These channels act as sediment sources and transport passages, leading to soil loss (Balasubramanian, 2017). The soil erosion by wind is common in the northern part of the country where high velocity wind and long period of dry season interact together to influence soil erosion in the area. In southeast Nigeria, wind erosion is not very common except during harmattan (Onyerika, 2016).

2.2.2.2 *Chemical degradation*

Chemical degradation indicates the accumulation of toxic chemicals and chemical processes which influence chemical properties that regulates life processes in the soil, a change in one or more of this soil chemical properties have direct and indirect adverse effects on the chemical fertility of soils (Tetteh, 2015). Chemically degraded soils have the presence of large amounts of toxic chemicals interfering with activities of soil life processes. These toxic chemicals may also interfere with nutrient availability, nutrient uptake and nutrient element mobility (Tetteh, 2015). According to Onyerika (2016), chemically, degraded soils may sustain crop growth over several seasons, but when there is no mitigating action; crop productivity gradually reduces to unprofitable levels.

Apart from yield loss, soil chemical degradation can pose a health hazard to humans as toxic substances may be absorbed by growing plants and then transferred into food chain on consumption of such contaminated crops. Chemical degradation is usually anthropogenic, caused by either agricultural activities or industrialization. Among the widespread types of soil chemical degradation that is ravaging the world; soil acidity is the one that is drastically affecting the soils of the world most, especially in Africa countries including Nigeria (Onyerika, 2016). Others are soil reaction (acidity and alkalinity), salinity, sodicity, and loss of mineral nutrients (through leaching, crop uptake and crop harvest).

In the tropics, acidification of soil is one of the major problems facing crop production. Acidification is the change in the chemical composition of the soil, which may trigger the circulation of toxic metals (Tetteh, 2015). Acidification impacts negatively on the soil ecosystem thereby causing damage to plants. It also results in the alteration of soil water chemistry. Soil acidification results from pH decline or from acid deposition. The phenomenon of acid deposition arises from the deposition of emissions from vehicles such as SO_2, power stations, other industrial processes and natural bio-geochemical cycles onto the soil surface mainly via rainfall and dry deposition (European Commission (EC), 2013).

Salinization is a process of chemical soil degradation, which greatly reduces soil productivity. Kavvadias (2014) defines salinization as the accumulation of water-soluble salts (including sodium, potassium, magnesium and calcium, sulphate, carbonate and bicarbonate) on or near the surface of the soil. Salinization involves the accumulation of different salts, but the increased content of exchangeable sodium (Na^+) in a soil resulting to a completely unproductive soil is referred to as sodification (Kavvadias, 2014). There are several means by which salt accumulates in the soil and this is compounded by the activities of humans.

According to Tetteh (2015), the source of soluble salts in the soil besides irrigation water are mineral weathering, fertilizers, salts used on frozen roads, atmospheric transfer of sea spray and lateral movement of ground water from salt containing areas. Chemical soil degradation processes include relatively simple changes, like nutrient depletion resulting from the imbalance of nutrient extraction on harvested products and fertilization, and more complex ones, such as acidification and increasing metal toxicity. Acidification in crop lands is increasingly driven by excessive nitrogen fertilization and to a lower extent by the depletion of cation like calcium, potassium or magnesium through exports in harvested biomass (Guo *et al.,* 2010).

One of the most relevant chemical degradation processes of soils in the context of climate change is the depletion of its organic matter pool. Reduced in agricultural soils through the increase of respiration rates by tillage and the decline of belowground plant biomass inputs, soil organic matter pools have been diminished also by the direct effects of warming, not only in cultivated land but also under natural vegetation (Bond-Lamberty *et al.*, 2018). There is a persistent debate however, on whether in more humid and carbon rich ecosystems the simultaneous stimulation of decomposition and productivity may result in the lack of effects on soil carbon (Crowther *et al.,* 2016; Van Gestel *et al.,* 2018).

In the case of forests, harvesting, particularly if it is exhaustive as in the case of the use of residues for energy generation, can also lead to organic matter declines (Achat *et al.*, 2015). Affected by many other degradation processes (e.g. wildfire increase, salinisation) and having negative effects on other pathways of soil degradation (e.g. reduced nutrient availability, metaltoxicity). Soil organic matter can be considered a “hub” of degradation processes and a critical link with the climate system (Minasny *et al.,* 2017).

2.2.3 Causes of land degradation

Socio-economic and institutional factors were the underlying causes of land degradation through their impacts on farmers’ decisions with respect to land use and land management practices (Mohammed and Teshome, 2015). Biophysical and unsustainable land management practices were the immediate causes of land degradation. Land degradation were classified into biophysical factors such as unsuitable land use (land use for the purpose which is environmentally unsuited for sustainable use), socioeconomic factors such as poor land management practices, land tenure, marketing, institutional support, income and human health, and political factors such as lack of incentives and political instability (Sisay. 2018). Similarly, the major causes include rapid population increase, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production. In addition, topography, soil types and agro ecological parameters were contributing factors in the degradation processes influenced by man (Sisay. 2018).

The most important on-farm effects of land degradation are declining potential yields. The threat of degradation may also be reflected in the need to use a higher level of inputs in order to maintain yields. Serious degradation sometimes leads to temporary or permanent abandonment of some plots. In other cases, degradation induces farmers to convert land to lower-value uses; for example, less-demanding cassava may be substituted for maize, fallow periods may be lengthened, cropland converted to grazing land, or grazing lands converted to shrubs or forests. For some farmers, degradation on a particular plot causes few economic problems: they adopt a Strategy of retiring that plot for a few years, or they use the soil eroded from the plot to build up topsoil on a flatter, downslope plot. Moreover, degradation processes such as soil erosion are not necessarily associated with yield declines; the threshold of yield response to changes in land quality may occur at different points, depending on the species or variety of crop and soil type or depth (Scherr and Yadav, 2009).

Busari (2010) opined that land degradation caused by agriculture takes many forms and has many causes. Some of the major causes of land degradation include: degradation related to overgrazing by livestock, degradation attributable to soil Stalinization, a buildup of salts in soil that result from irrigation in certain situations, degradation related to soil erosion, here related to inappropriate cultivation practices, degradation attributable to water logging another problem related to irrigation and diversion of tropical forests to agriculture (crop or pasture).

2.2.4 Perceived effects of land degradation on crop production

Effects of land degradation are enormous and it has devastating effects on agriculture, these effects should be a major source of concern to all. Several people have become refugees in their inherent communities because they are faced with fast expanding gullies around their homes due to land degradation which affects their production, markets and other infrastructures which is part of their source of livelihood (Onyerika, 2016). Nwosu (2014), enumerated what looked like a comprehensive list of the effects of land degradation on farmers agricultural production, this comprises of severe hardship, food shortage, soil nutrient loss, reduction in land productivity, increase in cost of input, increase in food prices, reduction in crop yield, death of livestock, destruction of markets and other infrastructure, loss of farmlands, destruction of economic trees, decrease in farm income, and loss of farm labour (due to forced migration).

An estimated 52 percent of agricultural land world-wide amounting to more than 2 billion hectares, is moderately or severely degraded, adversely affecting 1.5 billion people with a disproportionately high adverse impact on women, children and rural poor (FAO, 2018). Soils have become one of the most vulnerable resources in the world due to ongoing challenges of climate change, loss of bio-diversity and land degradation in a variety of ways. Despite enormous scientific and technological progress for conservation of soil, land degradation continues to face a variety of challenges on the ground, since there is still insufficient global support for the protection and sustainable management of the world's soil resources (FAO, 2018). Globally, over 20% of cultivated areas, 30% of forests and 10% of grasslands are suffering from varying degree of degradation, adversely affecting the livelihood of about 1.5 billion people. Land degradation is the combined result of numerous factors including unsustainable cultivation practices, over grazing, deforestation, soil erosion and climatic variations (Bai *et al*., 2008).

According to European Environment Agency, population growth coupled with urbanization is putting soils under pressure. Intensive agricultural is making soils more prone to erosion while sealing of soil surfaces due to increased urbanization and new infrastructure is the main cause of soil degradation in the most industrialized and populated countries. Localized contamination and diffuse contamination due to acidification of heavy metals are other important causes for soil degradation. (European Environment Agency, 2017). A comprehensive study undertaken by International Soil Reference and Information Centre (ISRIC) on land degradation, revealed that soil was constantly at risk from degradation by erosion, salinity, contamination and mismanagement. The study revealed that over-exploitation, over-grazing, inappropriate clearing techniques and unsuitable land use practices have resulted in severe nutrient decline, water and wind erosion, compaction and salinization. The degradation process has especially affected the marginally suitable lands that were taken into cultivation due to population pressure but was not given enough time to recuperate after prolonged cultivation. Four principal causes of soil degradation identified in the study are; water erosion, wind erosion, chemical deterioration and physical deterioration (ISRIC, 2016).

Marginal degradation can reduce the crop yield by 10 percent, moderate somewhere between 10 and 50 percent while severely degraded soil can reduce the crop yield by over 50%. Natural disasters like flooding and landslides can occur more frequently due to soil degradation. It can also result in turbidity of water while the contribution of nitrogen and phosphorus can result in eutrophication. Additionally, soil degradation could involve perturbation of microbial communities, disappearance of the climax vegetation and decrease in animal habitat, thus leading to loss of bio-diversity and animal extinction. Since the functioning of nature is a complex phenomenon with multiple factors and their inter-woven influences, it is not easy to predict the precise impact of individual factors adversely affecting the quality of land. (Gauri, 2010).

2.2.4 Adaptation strategies and methods of controlling land degradation

Onyerika (2016) itemized the strategies and methods employed by farmers in controlling land degradation for agricultural production. The methods are grouped into four different categories namely: Conservation method, Biological method, Chemical method, Mechanical method

2.2.4.1 *Conservation method*

Conservation farming is a method of farming which involves making the most efficient use of the land over a long period of time for sustained or increased yields with minimum soil loss. Conservation has been described as an activity embarked upon by human beings to attempt ways of satisfying their needs while ensuring that little or no damage is done to the environment and other organisms. This is through wise use of the natural environment, which includes protection of nature, controlled protection of useful materials as well as control or elimination of environmental pollution (Onyerika, 2016).

Several methods have been suggested to the farmers for the conservation of their soil. These include the planting of *vetiver* grass to reduce erosion, zero tillage and minimum tillage. Other methods include - afforestation, terracing, construction of contour ridge, cover cropping, alley cropping and agro-forestry, bush fallow, mulching, strip cropping, inter cropping, Irrigation and drainage, minimum tillage, buffer strip, contour farming (Onyerika, 2016). Vegetable cowpea (*Vigna unguiculata*) is widely cultivated as a food crop in the Southeast, and may have a high potential to act as a cover crop to check surface erosion while at the same time contributing to food security. This method of farming is a deliberate effort at controlling land degradation problem towards the process of food production.

2.2.4.2 *Biological method*

A number of biological and agronomic management practices are available for controlling soil erosion. Important among these are no-till, reduced tillage, crop rotations, cover crops, residue and canopy cover management, vegetative filter strips, riparian buffers, agroforestry, and soil synthetic conditioners. There are differences among these biological practices in relation to their mechanisms of erosion control. Biological measures such as crop residues, using manure, and applying conditioners are in direct contact with the soil surface and thus serve as buffers (e.g., residues) or thin films (e.g., conditioners) protecting the soil. In contrast, standing vegetation (e.g., cover crops) reduces soil erosion through the protective effect of its canopy cover which intercepts raindrops above the soil surface and by the mulching effect of residues produced by the growing vegetation. (Blanco-Canqui and Lal, 2010).

2.2.4.3 *Chemical method*

This method can be classified into two categories namely: Amelioration of acidic soils by liming, and fertilizer application to nutrient depleted soils. Acidic soils can be ameliorated through the addition of lime, lime is any material which upon reaction with the soil, increases the soil pH (decreases soil acidity) and does not add harmful elements to the soil. Soil nutrients may be depleted as a result of continuous cultivation, poor fertilizer practices or due to leaching by heavy rainfall. The application of appropriate chemical fertilizers to sustain crop growth will ensure minimal nutrient depletion after such crops are harvested. Care must be taken to ensure application at the specified rates and at the required stages of growth of the plant. (Onyerika, 2016).

2.2.4.4 *Mechanical method*

Building of dykes and embankments, landscaping to reduce slopes and construction of concrete channels are proven mechanical methods of intervention which have been used successfully to control land degradation. In land areas where degradation led to loss of topsoil, fresh topsoil is excavated from another location (perhaps undergoing road construction) and deposited on the degraded areas. Gullies may be filled with rocks and locked in with rust resistant wire mesh. All these involve heavy earth moving machinery, huge capital investment, and it is a radical, last resort approach to control physically degraded land (Nwachukwu, 2012). Example include: mounting an awareness campaign on the proper use of agricultural land, effective stakeholder participation in land use planning and management.

2.3 Theoretical Framework

Theory is a well-established principle that has been developed to explain some aspect of the natural world. Theories arise from observations and testings' that have been carried out repeatedly and they incorporate facts, predictions, laws, and tested assumptions that are widely accepted (Akintunde, 2017). The theoretical framework thus provides a platform for expressing a theory of a research study. It presents and describes the theory that explains why the research problem under study exists (Swanson and Chermack, 2013).

For many centuries, the environment has provided habitation for humans and numerous organisms but the insatiable needs of humans have driven them to devise strategies for survival and adaptation. Several of these strategies, especially technology, have had direct and indirect negative consequences on the immediate environment, resulting in the degradation of the latter. Many of today's environmental degradation problems are increasingly the outcomes of individual actions, personal consumer decisions, and the activities of small and large businesses (Akintunde, 2017). In order to understand human behaviors in environmental preservation, few theories will be reviewed below alongside their application to environmental preservation especially in areas of land degradation mitigation strategies. These theories and concepts will enhance the understanding of why people participate in different environmentally influencing behaviours. It is however evident, that no single theory, gives a perfect explanation of the complete interactions and relationships among variables influencing human behavior in environmental preservation

(Akintunde, 2017). The theories to be discussed in this study are Behavioural Change Model (BCM); Theory of Environmentally Responsible Behaviour (ERB) and Diffusion of Innovation Model.

2.3.1 Behavioural change model

This model is directly associated with the supposition that if people are well informed, they would become more aware of environmental problems surrounding them and consequently, would be motivated to behave in an environmentally responsible manner. Hence, there is likely positive relationship/link between knowledge to attitudes and attitudes to change in behavior/action. It is on the assumption that when knowledge increases, environmentally favourable attitudes that lead to responsible environmental actions are developed (Hungerford and Volk, 1990). Hence, the behavioral theory indicates that humans' awareness, perceptions, and behaviors are interconnected. Specifically, land protection awareness and land use behavior are closely linked and interrelated. For example, farmers with strong understanding/higher level of awareness of land degradation will probably adopt some land mitigation strategies, and these behaviors may further change their perspectives.

2.3.2 Theory of environmental responsible behavior

The ERB theory was proposed by Hines *et al.* (1987) and it argues that possessing an intention of acting is a major factor influencing ERB. The Model of Responsible Environmental Behavior indicates that the following variables; intention to act, locus of control (an internalized sense of personal control over the events in one's own life), attitudes, sense of personal responsibility, and knowledge influences whether a person would adopt a behavior or not (Akintunde, 2017). This model considers the major variables that play a part in the individual process of ERB adoption.

According to the model, the internal control centre has a very considerable impact on the intention of acting, which determines an individual's ERB substantially. This model also highlights the existence of a relationship between the control centre, attitudes of individuals and their intention to act. The authors asserted that the control centre directly affects an individual's attitudes which can lead to an improved intention of acting and improved behaviour. Thus, the theory concentrates more on existing interactions between parameters that influence a person's behaviour than on the singular impact of a single variable (Akintunde, 2017).

In the adoption of land degradation mitigation strategies, no single factor is responsible for current behaviors or sufficient to initiate behavior or cause behavior change. From the model, knowledge alone is grossly insufficient to act responsibly towards the environment, while some individuals' knowledge on the environmental problems and mitigation strategies available to them could prompt them to have a good attitude which could translate to good intentions to act, other individuals may go through the internal and external control, such as being influenced by the actions of others or holding strongly to a belief to act rightly despite the actions of others towards the environmental problems.

2.3.3 Diffusion of innovation model

In 1962, Everett Rogers introduced the concept of innovation diffusion (Rogers and Shoemaker, 1971). The theory purports that change spreads in a population through a normal distribution of willingness to accept new ideas. At the level of the individual, behavioral adoption occurs through the stages of knowledge, persuasion, decision, implementation and confirmation (Rogers and Shoemaker, 1971). According to diffusion theory, behaviors are affected across a community through change agents. There are four elements that would affect a change agent's own behavior while diffusing innovation and these are: involvement; social support; response information and; intrinsic control (Sheeran and Abraham, 1996). This model is important because of its ability to identify and assess the environmental literacy inducing information possessed by individuals, with respect to the content, sources, quality and effect; within a social context, social process and social support as upheld by this model (Akintunde, 2017).

2.4 Conceptual Framework

The conceptual framework describes the relationship between specific variables identified in the study. It furthermore outlines the input, process and output of an entire investigation (Regoniel, 2013). The dependent variable (cereal crop production) is expected to be negatively influenced by land degradation, the main effect of land degradation is reduction in the productivity of agricultural output. The conceptual framework shows the relationship between dependent, independent and intervening variables.

The dependent variable of the study is cereal crop production, while the independents variables are socio-economic characteristics, causes of land degradation, Methods of controlling land degradation. The intervening variable includes government policy, institutional factors, norms and beliefs. Age can have both negative and positive impact on farmer’s productivity, farmers within the active age are more likely to adopt new technology. While framers that are advanced in age are likely not to adopt new technology because of their traditional belief and socio-cultural norms. The more educated and exposed a farmer is, the more likely he/she is to adopt new control measures to land degradation that will improve his/her productivity and output. This is because an enlightened individual will have a better understanding on the desirability and consequently the benefits derivable from adopting new control measures.

Agricultural extension is basically designed to remove obstacles that are likely to inhibit increase food production among farm families. When farmers have firsthand information and knowledge of how to control land degradation, it will transcend to high output and productivity of cereal crops. Intervening variables such as government policy, availability of credit facilities, prevailing culture and norms can also influence cereal crop production, they can either accelerate or slow down the rate of production as shown in Figure 2.1.

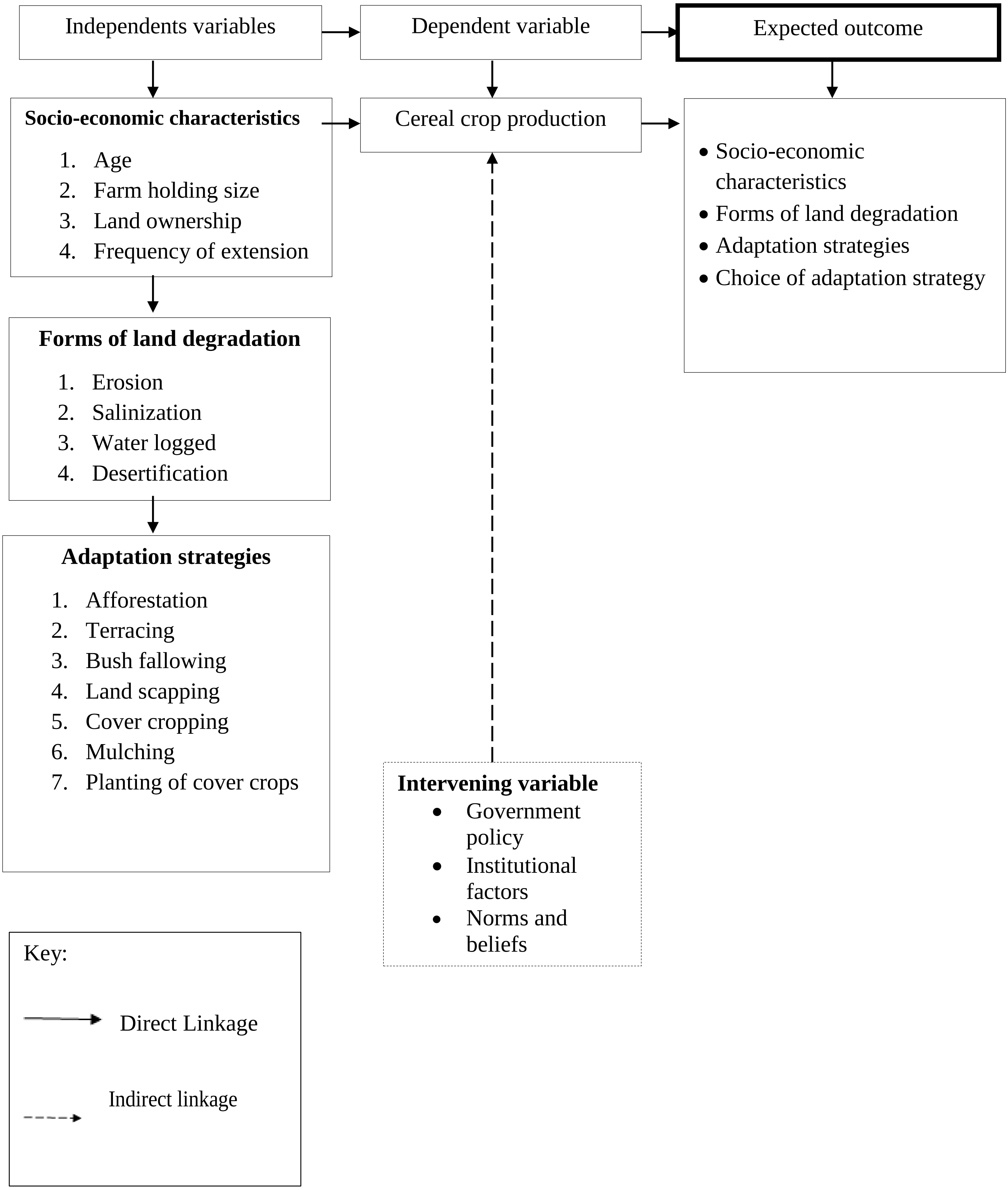

Figure 2.1: Conceptual framework of the Study

Source: Authors' work (2022)

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area

The study was conducted in Niger State, Nigeria. Niger State was created out of the former North Western State and became a fully autonomous State on 3rd February, 1976, with headquarter at Minna. Niger State is located in Guinea Savanna Ecological Zone of Nigeria and lies between Latitude 8^0 20’ and 11^0 30’ N and Longitude 38^0 30’ and 8^0 20’ E of the equator (Niger State Geographic Information System NSGIS, 2006). The State presently comprises of 25 Local Government Areas (LGAs) and it is made up of three major ethnic groups which are the Nupe, Gbagyi and Hausa. The State has population of 3,950,249 (National Population Commission (NPC), 2006) and at growth rate of 2.5%, the State was estimated to have a population of 6,722,378 in 2020 (National Bureau of Statistics (NBS), 2020).

Niger State shares common boundaries to the North with Zamfara State, to the North-East with Kaduna State, and to the South- East with the Federal Capital Territory (FCT). It also shares an International boundary with the Benin Republic at Babanna in Borgu Local Government Area of the State (nigerstateonline.com, 2013). The land area is about 76,363 square kilometers at a density of 72.76/square kilometer with varying physical features like hills, lowlands, rivers and luxuriant vegetation’s; vastly Northern Guinea Savannah while the fringe Southern Guinea Savannah is found in the Southern part of the State (NSGIS, 2007),

Niger State experiences distinct dry and wet seasons with annual rain fall varying from 1,100mm in the Northern part to 1,600mm in the Southern parts. The average annual rain fall is about 1,400mm. The duration of the rainy season is approximately 180days. The wet season usually begins in April/May to October, while the dry season starts from

November to March. Its maximum temperature is usually not more than 35ºC, while the minimum temperature is around 23ºC. Dry season commence in October (nigerstateonline.com, 2013).

Most of the communities in the State are predominantly agrarian. Some of the crops grown in the area are; yam, cotton, maize, sorghum millet, cowpea, soybean, beans, rice and groundnut. Some of the fruit crops are; shea, mango, citrus, coconut, cashew, banana and pawpaw. The inhabitants of the State also rear some livestock like goat, sheep, cattle and chicken among others. The other non-agricultural activities engage in by men includes blacksmithing. Leatherwork, mat and basket making, trading while women also engage in technical handicraft and trading.

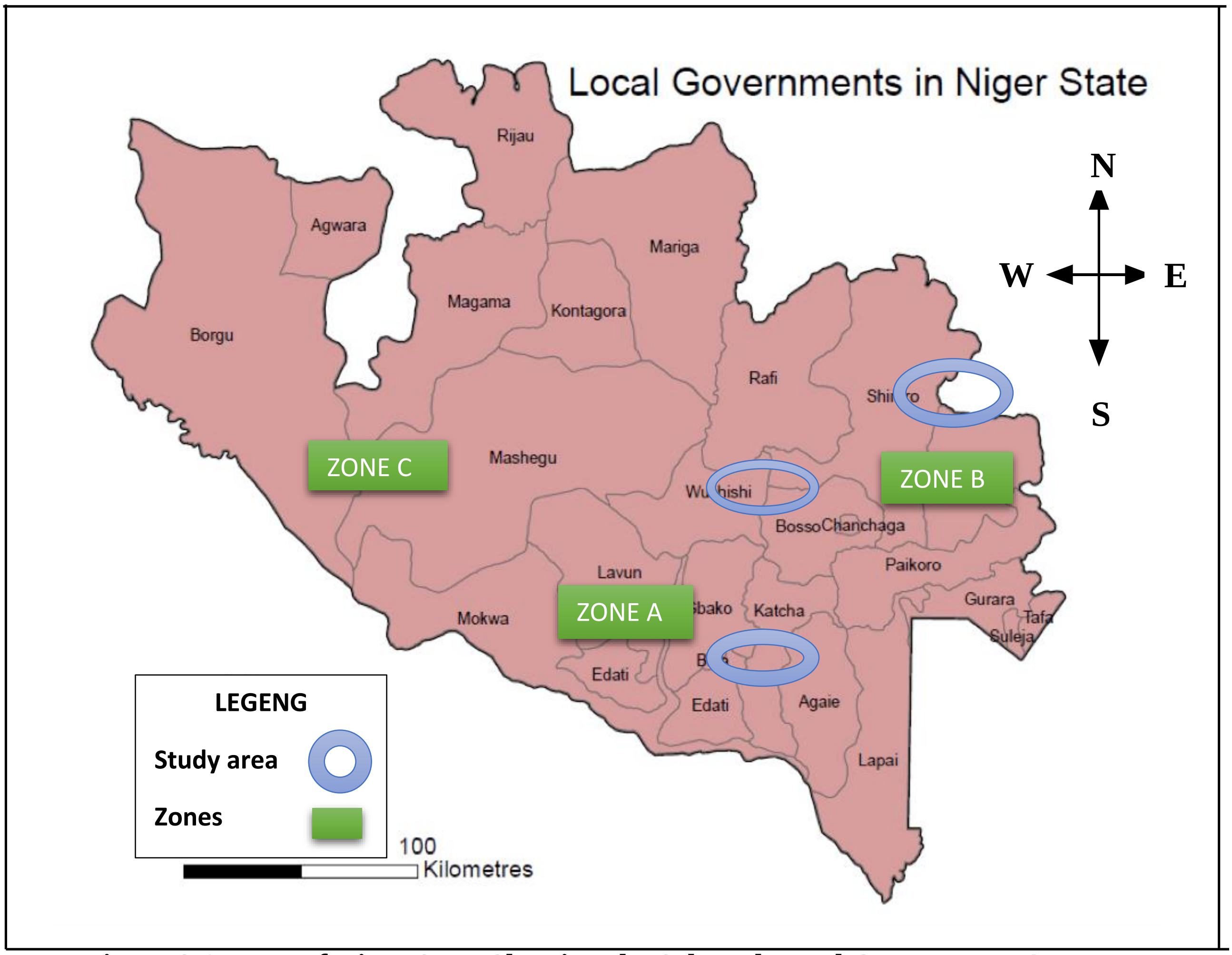

Figure 3.1: Map of Niger State Showing the Selected Local Government Areas from three (3) Agricultural Zones

3.2 Sampling Procedure and Sample Size

The population for this study was made up of rural farmers into cereal crop production in Niger State. Three stage sampling technique was adopted for this study. Niger State is divided into three Agricultural zones which are Zone I, Zone II and Zone III. The first stage involved random selection of one LGA from each of the zones to get 3 LGAs. In the second stage, three (3) villages were randomly selected from each of the selected LGAs to get 9 villages. The third stage involved proportionate selection of respondents with the use of Yamanne formula based on the sample frame of each village as obtained from Niger State Agricultural and Mechanization Development Authority (NAMDA). Thus, a total of 226 registered cereal crop farmers were selected as respondents for this study as shown in Table 3.1. The Yamanne equation for appropriate sample size determination as used by Abdullahi *et al.* (2018) is mathematically expressed as:

$$n = \frac{N}{1+N(e)^2} \quad (3.1)$$

Where;

n = samples size

N = finite population

e = limit of tolerable error (level of precision at 0.06 probability)

l = constant

Table 3.1: Sampling Outlay of Respondents in the Study Area

Zone	No. of LGA	Selected LGA	Selected Villages	Sampling Frame	Sample Size
I	8	Bida	Efu Ndatwaki	20	4
			Efu Madami	50	9
			Edzwayagi	65	12
II	9	Shiroro	Gwada	141	26
			Kafa	76	14
			Kuta	104	19
III	8	Wushishi	Lokogoma	175	32
			Wushishi	375	69
			Bankogi	225	41
Total	**25**	**3**	**9**	**1,231**	**226**

Source: Niger State Agricultural Mechanization and Development Authority, (2020)

3.3 Method of Data Collection

Primary data was used for this study. The data were collected through a structured questionnaire complemented with an interview schedule. The researcher was assisted by trained enumerators in the process of data collection. The data collected comprise of the socio-economic characteristics of cereal crop farmers in the study area, forms of land degradation prevalent in the study area, farmer's level of awareness on the types of land degradation, adaptation strategies adopted to mitigate land degradation by the farmers, perceived effectiveness of the adaptation strategies to land degradation and determinants of the adaptation strategies adopted to mitigate land degradation by the farmers in the study area.

3.4 Measurement of Variables

3.4.1 Dependent variable

The depend variable for the study was cereal crop output which was measured in kg

3.4.2 Independent variable

The following variables was measured as follows:

A. Socio-economic characteristics of the farmers in the study are

i. Age: Age of respondents was measured in years.

ii. Sex: This was measured as dummy variable where one (1) is assigned to male and zero (0) to female.

iii. Marital status: This was measured based on married (1), single (2), divorced (3) and widow (0).

iv. Level of Education: It was measured as the number of years the respondent has spent in school.

v. Land Ownership: It was measured as dummy variable where one (1) is assigned to owned land and zero (0) to no title to land.

vi. Farm size: this was measured in hectare(s) as the total size of the farm land used for cereal crop production.

vii. Farming experience: It was measured as the actual number of years the respondents have been involved in cereal crop farming.

viii. Household size: This was measured as the total number of people living within the family at the time of the study.

ix. Extension visit: This was assessed as the actual number of times that the farmer had contact with extension agents (EAs) on issues related to land degradation during the production season.

x. Cooperative membership: It was measured in years as well as dummy: member equals (1) and not a member equals (0).

xi. Farm income: It was measured as the total amount realized by the farmer from farming in Naira.

xii. Credit: It was measured as access to credit = 1, otherwise = 0. Also, amount of credit assessed in Naira was determined

B. The forms of land degradation prevalent in the study area was measured as dummy variable. Farmers were asked to respond to yes or no with respect to prevalent land degradation

C. The perceived effects of land degradation on cereal crop production was measured through the use of 5-point Likert rating scale of strongly agreed (SA) =5, agreed (A)=4, undecided (U)=3, disagreed (D)=2 and strongly disagreed (SD)=1. The reference mean for the scale was 3.0 (i.e. 5+4+3+2+1=15/5=3). Thus, the following decisions was derived; Mean ≥3 was adjudged as Agreed, while mean < 3 was adjudged as Disagreed.

D. The effectiveness of the adaptation strategies to land degradation employed by farmers in the study area will be measured through the use of 5-point Likert rating scale of Very Effective (VE) =5, Effective (E)=4, Indifferent (I)=3, Not Effective (NE)=2, Not Very Effective (NVE)=1. The mean value for the scale was 3.0 (i.e. 5+4+3+2+1=15/5=3). Thus, the following decisions was derived; mean ≥3 was adjudged to be effective adaptation strategies to land degradation, while mean <3 was adjudged not effective adaptation strategies to land degradation.

E. The adaptation strategies to land degradation adopted by the farmers in the study area was measured through the use of a 3-point Likert rating scale of Aware(A) =1, Tried (T) =2, Adopted (AD) =3, The reference mean for the scale was 2.0 (i.e. 3+2+1=6/3=2). Thus, the following decisions were derived; mean ≥2 was adjudged as adopted strategies to land. Degradation, while mean <2 was adjudged as not adopted strategies to land degradation.

3.5 Method of Data Analysis

The data collected were analyzed using both descriptive statistics (frequency distribution, percentage and mean) and inferential statistics (Poisson regression model). Descriptive statistics was used to achieve objective i, ii, iii, iv and v of the study. However, 5-point likert rating scale was used to measure objective iii & v, while 3-point likert rating type scale was used to measure object iv. The Z-value from the Poisson regression was used to test for hypothesis I. Meanwhile, objective vi was achieved through the use of Poisson regression model analysis and the hypothesis II was tested using Pearson Moment Correlation (PPMC).

A summary of the analytical tools for the study are presented below:

Objective i: Descriptive statistics (mean, percentages and frequency distribution)

Objective ii: Descriptive statistics (mean, percentages and frequency distribution)

Objective iii: Descriptive statistics (mean, percentages and frequency distribution)

Objective iv: Descriptive statistics (mean, percentages and frequency distribution)

Objective v: Descriptive statistics of mean, percentages and frequency distribution

Objective vi: Poisson regression model

Hypothesis: Pearson Product Moment Correlation (PPMC).

3.6 Model Specification

3.6.1 Poisson regression model

Poisson regression is a form of regression analysis used to analyze count data and contingency variables. Poison regression assumes that the response variable Y has a Poisson distribution and the logarithm of its expected value which can be modeled by a linear combination of unknown parameters. Poisson regression model is sometimes known as log- linear model, especially when used to model contingency variables. Thus, the Poisson regression model is expressed in implicit form as:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \ldots\ldots\ldots\ldots\ldots\ldots + \ldots\ldots\ldots X_n$ (3.2)

The model is expressed in the explicit form as:

$Y=b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + bnXn + U$ (3.3)

Where:

Y = Adaptation strategies to mitigate land degradation (number adopted)

X_1 = Age (in years);

X_2 = Household size (numbers of people in the household);

X_3 = Level of education (Years spent in school);

X_4= Farming experience (years spent in farm);

X_5= Extension contact (number of visits);

X_6= Access to training (number of time);

X_7= Access to credit (₦);

X_8 = Farm income (₦);

X_9 = Farm output (kg);

X_{10} = Sex (1 if male; 0 if otherwise)

X_{11} = Marital status (1 if married; 0 if otherwise)

X_{12} = Goal of farming (1 if commercial; 0 if otherwise)

$B_n – b_n$ = Regression coefficient

$X_n – X_n$= Independent variable

U = error term

3.6.2 Pearson product moment correlation (PPMC)

Hypothesis II of the study was tested using pearsons product moment correlation (PPMC).

The Pearson Product Moment-Correlation is a measure of the linear relationship between two question/measures/variables, X and Y. The correlation value can range from +1 to -1

The PPMC model is specified as:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \qquad (3.4)$$

Where,

r = correlation coefficient

y = dependent variable

x = independent variables

n = total number of observations

∑ = summation

3.7 Unit of Measurements and *Apriori* expectation of Explanatory variables X

The unit of measurement is presented in Table 3.2

Table 3.2: Unit of Measurement and a *Apriori of* explanatory variables in the logit Models

Explanatory variables	Parameter	Variables	Expected Sign
Age (Years)	β_1	X_1	+
Level of Education household (in Years)	β_2	X_2	+
Household Size (Number)	β_3	X_3	+
Farming Experience (Years)	β_4	X_4	+
Access to credit (1, Access; 0, otherwise)	β_5	X_5	+
Member of cooperative society (1, Yes; 0, otherwise)	β_6	X_6	+
Contact with extension agent (1, Yes; 0, otherwise)	β_7	X_7	+
Farm size (in hectares)	β_8	X_8	+
Marital Status (Single, Married, divorced, widow)	β_9	X_9	+
Income (in Naira)	β_{10}	X_{10}	±

Source: Authors concept (2021)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of Respondents

This section presents and discusses the results of the study on socio-economic characteristics of the respondent in the study area which comprises age, marital status, secondary education and level of education among others.

4.1.1 Age of the respondents

Table 4.1 revealed that the mean age of the respondents in the study area was 39 years. This is an indication that farmers were within their active and productive age. At this age, the respondents could be classified as being strong, inquisitive and risk takers. These set of respondents are always willing and ready to adopt innovation and improved practices on soil conservation that will improve their productivity. This also implies that the respondents can engage in other economic activities aside farming, which can further improve their livelihood status. This result concurs with that of Gido *et al.* (2013) were asserted that age had positive relationship with soil management practices.

4.1.2 Sex of the respondents

Result in Table 4.1 showed that majority 82.4% of the respondents were male while 17.6% were female. This signifies that men were more into farming than their female counterpart in the study area. This can be ascribed to the tedious activities involved in farming and inadequate land ownership among women in the study area. It can also be attributed to women engagement in marketing and other post-harvest activities in cereal crop farming. This findings agrees with Chukwuone *et al***.** (2006) who reported that majority of their respondents into cereal crop farming in Ogun State were male farmers.

4.1.3 Marital status of the respondents

Table 4.1 revealed that majority 87.7% of the respondents were married, 5.7% were single, 4% were widowed and 2.6% were divorced. This implies that married respondents dominate farming in the study area. This might be associated with common cultural practice among agrarian societies where farmers marry early in order to have more labour supply to carryout farming activities, this can go a long way in boosting farm income and improving the livelihoods of rural farmers in the study area. This findings agrees with the study of Austin and Nahanga (2017) who reported that most of their respondents in the the study area were married.

4.1.4 Educational level of the respondents

As revealed in Table 4.1, most (66.5%) of the respondents had access to formal education, while 33.5% did not have access to formal education. This implies that the respondents acquire formal education that could help them overcome problem of land degradation. High literate farmers are more likely to adopt innovation and improve practices that will enhance productivity and income. This may help them better understand initiatives and policies aimed at improving soil conservation as well as equipping them with the required impetus needed to adopt adaptive strategies to mitigate land degradation. This finding is similar to the study of Ogunjinmi *et al.* (2017) reported most of the respondents in Ekiti State had formal education

Table 4.1: Distribution of Respondents According to Socioeconomic Characteristics

Variables	Frequency	Percentage (%)	Mean
Age			
Less than 21	64	28.9	
21 – 30	74	32.6	
31 – 40	63	27.8	39
41 – 50	26	11.5	
Sex			
Female	40	17.62	
Male	187	82.4	
Marital status			
Married	199	87.7	
Single	13	5.7	
Divorced	6	2.6	
Widow	9	4.0	
Household size			
Less than 11	106	46.7	
11 – 20	102	44.9	12
30 – 40	12	5.3	
Above 40	7	3.1	
Level of education			
No formal education	76	33.5	
Primary	7	3.1	
Secondary education	73	32.2	
Tertiary education	71	31.3	
Sources of labour			
Family	70	30.8	
Hired	29	12.8	
Both	128	56.4	
Farming experience			
Less than 10	66	29.1	
11 – 20	94	41.4	18
21 – 30	47	20.7	
31 and above	20	8.8	
Main goal of farming			
Family consumption	32	14.0	
Commercial purpose	6	2.6	
Both	189	83.3	

Source: Field survey (2022)

4.1.5 Household size of the respondents

Table 4.1 showed that half (50.2%) of the respondent had household size between the range of 11 – 40 members, 46.7% had household size of less than 11 members and 3.1% had household size of above 40 members. The average household size was 12 members. This implies that majority of the respondents had large household size. The finding agrees with Akinnagbe and Umukoro (2011) who reported that most of their respondents in Ethiope, East Local Government Area of Delta State had large household size. Large household size is proportional to labour availability and reduce the amount spend on hired labour. Although, large household size is a reflection of a high level of dependency since the larger the household size, the higher the number of mouths to feed which may increase the household expenditure.

4.1.6 Farming experience of the respondents

Table 4.1 revealed that most 62.1% of the respondents had farming experiences between the ranges of 11 – 30 with an average farming experience of 18 years. This implies that, the respondents were experienced farmers; and might have acquired enough farming experience needed to understand the effects of land degradation on farming activities in the study area. More so, farming experience is expected to enhance ability to adopt suitable adaptive strategies to mitigate against land degradation. This result agrees with the findings of Ogunmefun and Achike (2015) who reported that majority of respondents in their study area were experienced farmers.

4.1.7 Sources of labour by the respondents

Findings in Table 4.1 revealed that 56.4% of the respondents used both family and hired labour in their farming activities, 30.8% used family labour and 12.8% used hired labour for carrying out their farming activities. This implies that most of the farmers in the study area used family and hired labour in their farming operation.

4.1.8 Main goal for farming by the respondents

Table 4.1 revealed that majority (83.3%) of the respondents were into farming for both family consumption and commercial purpose while 14% produce for family consumption and 2.6% produced for commercial purpose. This is implies that majority of respondents engaged in agriculture for both family consumption and commercial purpose. This is expected to enhance their level of commercialization and income status which will pave ways to adopt various land degradation adaptive strategies.

4.1.9 Access to credit

Figure 4.1 revealed that more than half (57.0%) of the respondents had access to credit while 43.0% do not have access to credit. Credit is projected to strengthen farmers' purchasing power, and as a result improve their adoption rate. If correctly exploited, it has the potential to break the vicious cycle of food insecurity and increase the production capacity of farming households. Credit is a key factor in starting or expanding a farm business. Access to financial services will go a long way toward enhancing agricultural production on small-scale farmer. This result is in line with the findings of Asogwa (2014), who found that the most of peasant farmers in his study area have access to loans.

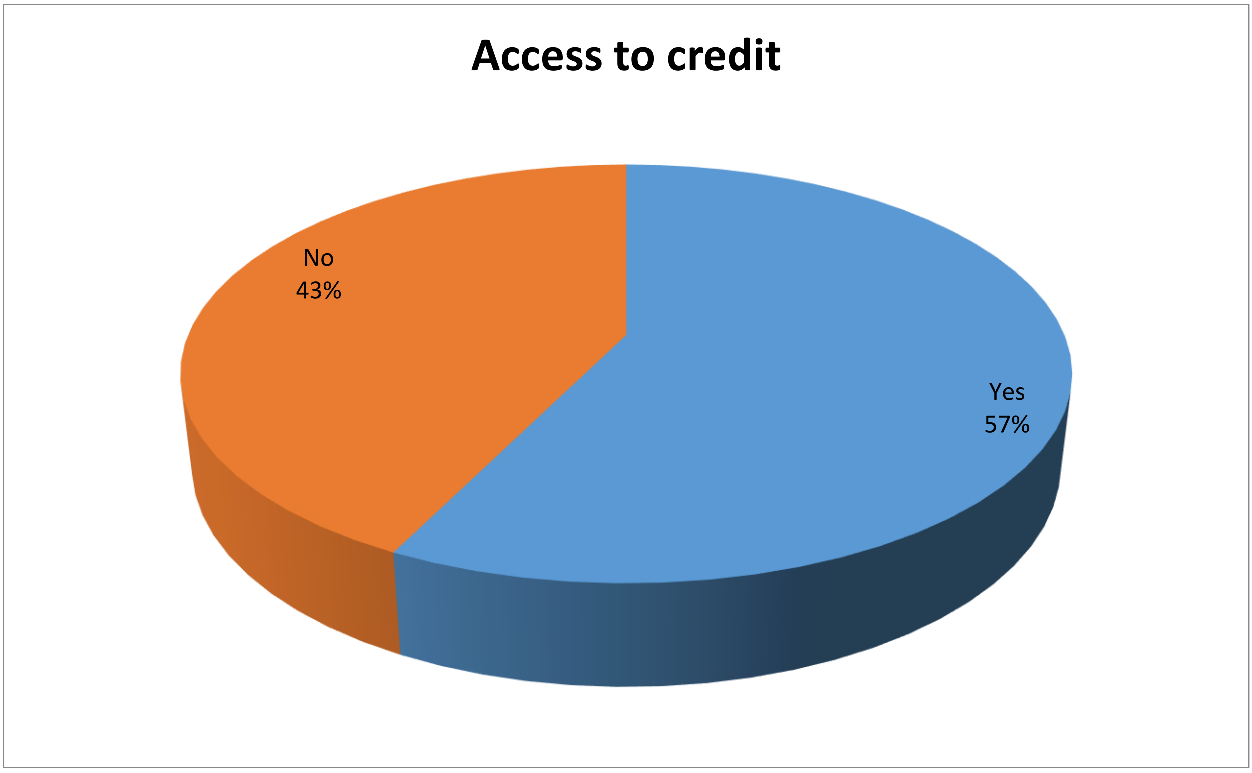

Figure 4.1: Distribution of Respondents According to Access to Credit

4.1.10 Membership of cooperative society

Figure 4.2 revealed that 45% of the respondents in were members of agricultural cooperative societies, while 55% were non-members of agricultural cooperatives. This implies that the participation in agricultural cooperative among respondents in the study area was low. Agricultural cooperative societies are essential to agricultural development. Cooperative membership is often used as a proxy for social capital and it is useful in address issues and challenges members are facing. This findings agrees with Ogunbameru *et al.* (2008) who reported that participation in cooperative have the potential of creating confidence among members to come together in order to find solution to the challenges they are facing.

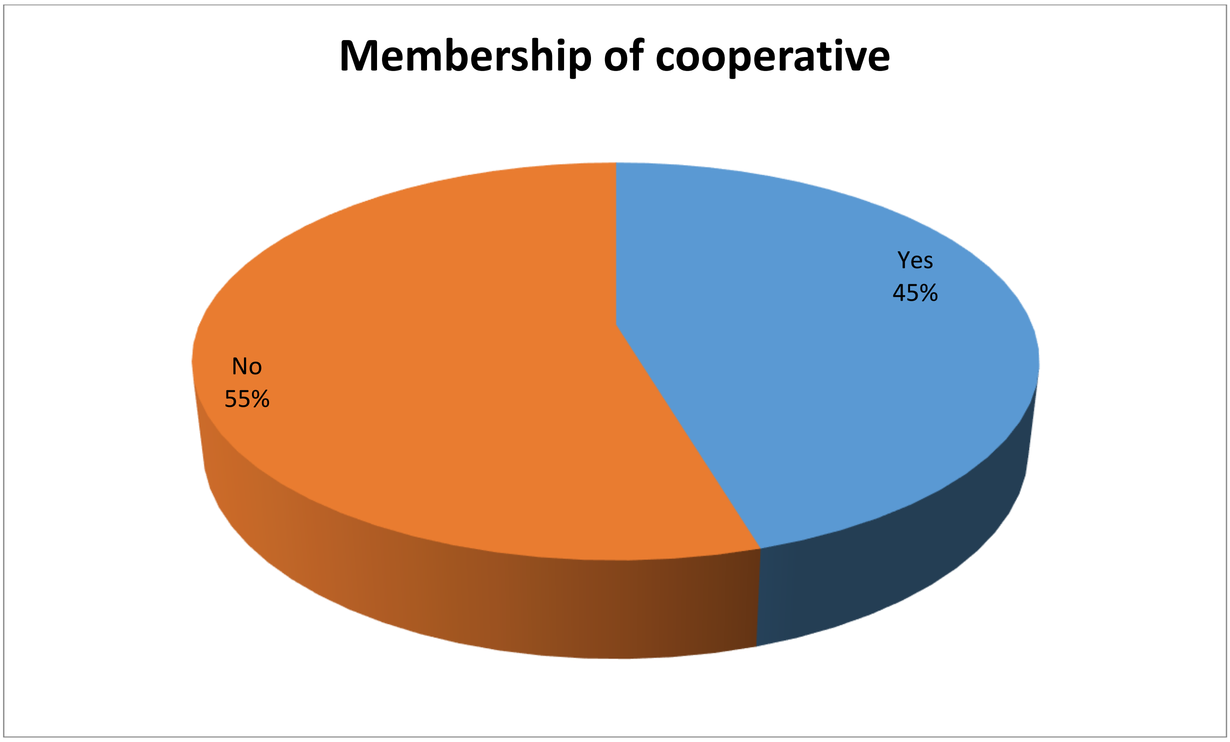

Figure 4.2: Distribution of Respondents According to Membership of Cooperative

4.2 Forms of Land Degradation Experienced by the Respondents

4.2.1 Forms of land degradation

The study revealed that runoff (89.8%), waterlogged (78.9%) and soil structure destruction (75.3%) ranked 1st, 2nd and 3rd respectively were the physical land degradation experienced by cereal crop farmers, while low nutrient availability (96.5%) and increase soil acidity (72.1%) ranked 1st and 2nd respectively were the major chemical land degradation experienced by cereal crop farmers in the study area. This is similar to the findings of Onyerika (2016) who reported that runoff and soil acidification were the major type of land degradation in the study area. Excess water that exceeds the amount that the soil can absorb usually result in runoff which can wash away rich topsoil. Also, activities of man, like poor irrigation and drainage system as well as natural occurrences like floods usually contribute to the runoff and subsequently results to water-logging. Meanwhile Waterlogged reduces aeration in the soil, thereby **lowering oxygen levels in the root zone, which reduces plant growth.**

More so, poor agricultural practices such as tilling soil too frequently, the illegal cutting down of economic trees and the increase in population that leads to the construction of buildings and roads can lead to soil compaction, which invariably destroys the soil structure. In addition, the low nutrient availability, which is a situation where there is a lack of essential nutrients in the soil can significantly reduce the farmers' yield. An increase in soil acidity can have negative effects on plant growth, as acidic soil makes it difficult for plants to absorb essential nutrients from the soil. The rate of land degradation in the study area has resulted in many farmers using different types of fertilizer to boost the nutrient status of the soil, and some of these synthetic fertilizers have also contributed to soil acidification as shown in Table 4.2.

Table 4.2: Distribution of Respondents According to Forms of Land Degradation

Variables	Frequency	Percentage (%)	Rank
Physical Land Degradation			
Runoff	204	89.87	1st
Waterlogged	179	78.85	2nd
Soil structure destruction	171	75.33	3rd
Low infiltration	62	27.31	4th
Dispersion of soil	59	25.99	5th
Reduce root generation	51	22.4	6th
Sealing of pore spaces	44	19.38	7th
Accelerated erosion	35	15.42	8th
Compression, and increase density	5	2.20	9th
Chemical Land Degradation			
Low nutrient availability	219	96.48	1st
Increase soil acidity	163	72.12	2nd
Low nutrient uptake	95	41.85	3rd
High level of alkalinity	43	18.94	4th
High mobility of element	39	17.18	5th
Salinity and sodicity	14	6.17	6th
Present of toxic substances	12	5.29	7th

Source: Field survey (2022), * Multiple responses were recorded

4.3 Perceived Effects of Land Degradation on Cereal Crop Production Output

The result in Table 4.3 showed that soil nutrients loss ($\bar{X}$=4.5) ranked 1st among the perceived effects of land degradation on cereals crop output, this was followed by occurrence of soil erosion and reduction of crop yield ($\bar{X}$=4.3) ranked 2nd. Others include increase labour supply ($\bar{X}$=3.9), low output of farm produce ($\bar{X}$=3.9) and reduced in labour productivity ($\bar{X}$=3.8) ranked 5th and 7th respectively. In addition, the use of recommended high seeds during cultivation ($\bar{X}$=3.7), reduction of income ($\bar{X}$=3.7) and previous cultivated field abandon due to poor nutrient ($\bar{X}$=3.7) ranked 8th were perceived by cereals crop farmers as the effects of land degradation on their output. This concurs with Nwosu (2014) who reported that severe hardship, food shortage, soil nutrient loss, reduction in land productivity, increase in cost of input, increase in food prices, reduction in crop yield, death of livestock, destruction of markets and other infrastructure, loss of farmlands, destruction of economic trees, decrease in farm income, and loss of farm labour (due to forced migration) were the perceived effects of land degradation on farmers agricultural production.

Soil nutrients are essential for plant growth and development, when soil nutrients are lost due to various factors such as erosion, leaching, and improper management, crop yields are reduced. This is because plants are unable to access the nutrients they need to grow and produce healthy yields. Soil erosion also have a significant impact on crop yield, when soil erosion occurs, it removes the top layer of soil which contains many of the nutrients and organic matter that plants need to grow. The loss of top layer of soil can reduce the ability of the soil to retain water making it more difficult for plants to access the water needed for grow. Additionally, soil erosion also exposes the roots of plants to the elements which can make them more vulnerable to stress and disease. All of these factors could contribute to lower crop yields (Gauri, 2010).

Furthermore, as agricultural productivity decreases, farmers may need to work longer hours or hire additional labour in order to maintain their operations or achieve high level of crop production. Land degradation increases the supply of labour in agricultural sector as farmers seek additional workers to help manage their land and crops. This usually decreases the income of the farmers as more expenses are incurred during farming operation (ISRIC, 2016) as shown in Table 4.3.

Table 4.3: Effects of Land Degradation on Cereal Crop Production Output

Effects	Weight sum	Weight mean	Rank	Decision
Soil nutrient loss	1031	4.5	1st	Agreed
Occurrence of soil erosion which reduce soil nutrient	981	4.3	2nd	Agreed
Reduce crop yield	971	4.3	2nd	Agreed
Farmers spend resources on how to improve their land	930	4.1	4th	Agreed
Low output of farm produce	886	3.9	5th	Agreed
Increase labour supply	880	3.9	5th	Agreed
Reduce land productivity	859	3.8	7th	Agreed

Recommended high seeds are during cultivation	834	3.7	8th	Agreed
Previous cultivated field abandon due to poor nutrient	830	3.7	8th	Agreed
Reduce farmers income	841	3.7	8th	Agreed
Shifting cultivation become less come	806	3.6	11th	Agreed
Changes cropping system over the year	745	3.3	12th	Agreed

Source: Field survey (2022)

4.3.1 Effects of land degradation on cereal crop production on output

Results in Table 4.4 revealed the OLS regression estimate on the effects of land degradation on output of cereal crop farmers in the study area. The results showed the R-squared was 0.7898 which implies approximately about 79% variation in crop output was explained by the independent variable included in the model while the remaining 21% could be error or other variables not captured. The finding revealed that out of the eight (8) variables included in the model, six (6) variables were statistically significant at various probability levels .

The coefficient for occurrence of erosion (126.67) was negative and statistically significant at 0.01 probability level. This implies that a unit increase in occurrence of erosion will leads to decrease in the output of cereal crop farmers as a result of land degradation. This is in line with the *a priori* expectation because Erosion can strip away valuable topsoil, which contains essential nutrients and organic matter necessary for healthy crop growth. It can also disrupt soil structure and reduce the water-holding capacity of the soil, making it more difficult for crops to access the moisture and nutrients they need to thrive. Farmers who experience high levels of erosion may be forced to invest more resources in soil conservation and land restoration measures, which can reduce their overall crop yields as shown in Table 4.4.

Table 4.4: OLS Regression on Effects of Land Degradation on Cereal Crop Yield

Variable	Coefficient	Standard error	t-value
Occurrence of erosion	-126.67	43.0573	-2.94***
Changes in cropping system	.1502	.4154	0.36
Spending more resources on land	.4782	.2163	2.21**
Low output	.4343	.3992	-1.5
Reduces farmers income	.3777	.3151	1.20
Increase labour supply	- .9036	.4003	-2.26**
Reduction in land productivity	.3794	.0955	-3.97***
soil nutrient loss	- 1.8754	.5853	-3.20***
Constant	3.8410	1.1769	3.26***
R-squared	0.7898		
Adj R-squared	0.7562		
Prob > F	0.0000		

Source: Field survey (2022)

Keys: *** = Significant at 1% level of probability
**=Significant at 5% level of probability
*=Significant at 10% level of probability

The coefficient for spending more resources on land (.4782) was positive and statistically significant at 0.05 probability level. This implies that the more resource is spent to control land degradation the increase the output of cereal crop farmers. This is in line with the *a priori* expectation because investing in sustainable land management practices can lead to higher crop yields and improved soil health. Farmers who spend more resources on controlling land degradation may be using more effective and efficient practices, such as conservation tillage, cover cropping, or agroforestry, which can help to improve soil structure, nutrient content, and water-holding capacity, and ultimately increase crop yields.

The coefficient for increase labour supply (.9036) was negative and statistically significant at 0.05 probability level. This implies that a unit increase in labour supply will leads to decrease in the output of cereal crop farmers as a result of land degradation. This result is in line with the a priori expectation because an increase in labour supply may imply that farmers are using more labor-intensive methods to cultivate their crops, such as manual weeding, planting, and harvesting. These methods can be time-consuming and may result in a decrease in the amount of time spent on land management practices, leading to increased land degradation.

The coefficient for reduced land productivity (.3794) was negative and statistically significant at 0.05 probability level. This implies that a unit increase in reduce land productivity will leads to decrease in the output of cereal crop farmers as a result of land degradation. This result is in line with the *a priori* expectation because reduced land productivity is a direct consequence of land degradation, which can negatively affect cereal crop yields. When land productivity decreases, it means that the soil is no longer able to support optimal crop growth due to factors such as nutrient depletion, erosion, and soil compaction. These factors can limit plant growth and reduce the amount of water and nutrients available to crops, leading to reduced yields. Therefore, it is expected that an increase in reduced land productivity, as a result of land degradation, will lead to a decrease in cereal crop output.

The coefficient for soil nutrient loss (.8754) was negative and statistically significant at 0.01 probability level. This implies that a unit increase in soil nutrient loss will leads to decrease in the output of cereal crop farmers as a result of land degradation. This result is in line with the *a priori* expectation because soil nutrient loss is a common consequence of land degradation. When nutrients are lost from the soil, it can negatively affect cereal crop yields because plants require a balanced supply of nutrients for optimal growth and development. Soil nutrient loss can be caused by several factors, including erosion, leaching, and overuse of fertilizers. As a result, it is expected that an increase in soil nutrient loss, as a result of land degradation, will lead to a decrease in cereal crop output.

4.4 Adaptation Strategies to Mitigate Land Degradation

The results in Table 4.5 revealed the adaptation strategies adopted by crops farmers to reduce the effects of land degradation on their crop production. It shows that majority (87.2%) of the respondents adopted terracing to reduce the menace of land degradation which ranked 1st. Terracing is a technique that involves the creation of stepped levels or flat platforms on sloping land. This can be an effective adaptation strategy against land degradation because it helps to reduce erosion and soil loss which can occur when water and wind remove topsoil from sloping land. The other adaptation strategies adopted by cereal crop farmers in the study areas includes mixed farming (68.7%), use of organic manure (63.9%), use of inorganic manure and afforestation (55.5%) which ranked 1st, 2nd, 3rd and 4th respectively.

Mixed farming is a type of agricultural system in which varieties of crops and animals are raised together on the same land. This can serve as adaptive strategy against land degradation because it help increase the sustainability and productivity of the land over the long term. It helps to increase the fertility of the soil by incorporating animal manure and other organic matter into the soil. This reduces the need for synthetic inputs and also provides range of products, in both crops and livestock. The use of organic manure as a fertilizing agent can be an adaptive strategy against land degradation because it can help to improve the fertility and structure of the soil, thereby reducing the risk of soil erosion and degradation. More so, afforestation which is the process of planting trees in an area where there was previously no forest can be an adaptive strategy against land degradation because trees can help stabilize the soil, reduce erosion and improve the overall health of the land as shown in Table 4.5.

Table 4.5: Distribution of Respondent According to Adaptation Strategies Adopted

Adaptive strategies	Frequency	Percentage (%)	Rank
Terracing	198	87.2	1st
Mixed farming	156	68.7	2nd

Organic manure	145	63.9	3rd
Afforestation	126	55.5	4th
Inorganic manure	126	55.5	4th
Mixed cropping	99	43.6	6th
Combination of organic and inorganic fertilizer	90	39.7	7th
Crop rotation	89	39.2	8th
Zero tillage	67	29.5	9th
Intercropping	62	27.3	10th
Fallowing	51	22.5	11th
Stone line	48	22.2	12th
Planting of grass	26	11.5	13th

Source: Field survey (2022)

4.5 Perception of Farmers on Effectiveness of the Adaptation Strategies to Mitigate Land Degradation

Table 4.6 revealed the result of perception of farmers on effectiveness of the adaptation strategies to mitigate land degradation. The result showed that terracing ($\bar{X}$=4.5) ranked 1st as most effective adaptive strategies on land degradation, this was followed by Mixed farming ($\bar{X}$=3.6), Inorganic manure ($\bar{X}$=3.6), afforestation ($\bar{X}$=3.3) and organic manure ($\bar{X}$=3.1) which ranked 2nd, 3rd, 4th and 5th respectively.

Terracing helps to reduce soil erosion by creating a series of terraces or flat steps on the slope, allowing water to drain away and preventing soil from being washed away. Creating terracing involves technical skills reason why it is highly adopted among cereal crop farmers. More so, mixed farming, inorganic and organic fertilizers all improve soil fertility this easily adopted by cereal crop farmers in mitigating land degradation. These strategies are the most effective in reducing land degradation among cereal crop farmers thereby improving soil structure, fertility and the overall productivity of the cereal crop farmers in study area. The result is corroborated with the study of Onyerika, (2016) who reported that methods suggested to the farmers for the conservation of their soil includes the planting of *vetiver* grass to reduce erosion, zero tillage and minimum tillage. Other methods include - afforestation, terracing, construction of contour ridge, cover cropping, alley cropping and agro-forestry, bush fallow, mulching, strip cropping, inter cropping, Irrigation and drainage, minimum tillage, buffer strip, contour farming as shown in Table 4.6.

Table 4.6: Distribution of Respondents on their Perception on the Level of Effectiveness of Adaptation Strategies

Adaptive strategies	VE (%)	E (%)	I (%)	NE (%)	NVE (%)	WS	WM	Decision	Rank
Terracing	133(58.6)	72(31.7)	20(8.8)	1(0.4)	1(0.4)	1016	4.5	E	1st
Mixed farming	26(11.45)	122(53.7)	47(20.7)	17(7.5)	15(6.6)	808	3.6	E	2nd
Inorganic manure	47(20.7)	66(29,1)	82(36.1)	4(1.8)	28((12.3)	781	3.4	E	3rd
Afforestation	40(17.6)	78(34.4)	50(22.0)	19(8.4)	40(17.6)	740	3.3	E	4th
Organic manure	22(9.7)	70(30.8)	46(20.3)	83(36.6)	6(2.6)	700	3.1	E	5th
Planting of grass	11(4.9)	25(11.0)	143(63.0)	29(12.8)	19(8.4)	661	2.9	NE	6th
Stone line	24(10.6)	73(32.2)	46(20.3)	16(7.1)	68(30.0)	650	2.9	NE	6th
Crop rotation	40(17.6)	56(24.7)	35(15.4)	33(14.5)	63(27.8)	658	2.90	NE	6th
Zero tillage	30(13.2)	60(26.4)	36(15.9)	45(19.8)	56(24.7)	644	2.84	NE	9th
Use of organic and inorganic fertilizer	13(5.7)	51(22.5)	78(34.4)	37(16.3)	48(21.2)	625	2.75	NE	10th
Mixed cropping	26(11.5)	50(22.0)	39(17.2)	35(15.4)	77(33.9)	594	2.62	NE	11th
Intercropping	21(9.3)	37(16.3)	54(23.8)	50(22.0)	65(28.6)	580	2.56	NE	12th

Source: Field survey (2022)

KEY: VE=very effective, E=effective, I=indifferent, NE=not effective and NVE=not very effective

4.6 Factors Influencing Choice of Adaptation Strategies to Land Degradation

Results in Table 4.7 revealed the Poison regression estimate on the factor influencing the choice of adaptation strategies to land degradation in the study area. The results showed Pseudo R^2 of 0.3362 which is a relatively good fit for the poisson regression model, while the Chi-square result of 34.74 show that the likelihood ratio statistics was statistically significant at 0.01 probability level, suggesting that the poison regression model has strong explanatory power of the variables included in the model. The finding revealed that out of the twelve (12) variables included in the model, eight (8) variables were statistically significant at various probability levels. The study agreed to the report of Blanco-Canqui and Lal (2010) who opined that standing vegetation (cover crops) reduces soil erosion through the protective effect of its canopy cover which intercepts raindrops above the soil surface and by the mulching effect of residues produced by the growing vegetation.

The coefficient for age (.01385) was negative and statistically significant at 0.01 probability level. This implies that a unit increase in age may likely leads to decrease in the choice of adaptation strategies to land degradation. This is in line with the *a priori* expectation, although older farmers may have more experience and resources that would allow them try new practices but they may be too weak to perform difficult farm operations. In addition, some older farmers are too conservative to try out new innovation. This result negates the study of Gido *et al.* (2013) who reported that age had positive relationship with organic soil management practices.

The coefficient for level of education (.0926) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in educational level may likely leads to increase in the choice of adaptation strategies to land degradation. This is in line with *a priori* expectation because education is believed to enhance farmers' exposure to new ideas and innovation. Educated individual is expected to have better knowledge to efficiently analyse and use available information to make rational decision for adoption of the land management strategies. This findings agrees with the study of Tesfaye (2018) who reported that levels of education significantly and positively determined farmers' perception on the risk of decline in agricultural land productivity due to land degradation and soil erosion in Jeldu District in West Shewa Zone, Oromia, Ethiopia as shown in Table 4.7.

Table 4.7: Factors that Influence the Choice of Adaptation Strategies to Land Degradation

Variables	Coefficient	Standard error	z-values
Age	-.01385	.0048	-2.90***
Household size	. 0031	.0057	0.54
Level of education	.0926	.0284	3.26***
Farming experience	-.0027	.0055	-0.49
Extension contact	.0440	.0233	1.89*
Training received	.0950	.0521	1.82*
Access to credit	.1066	.0401	2.66***
Farm income	-6.71e-09	4.31e-08	-0.16
Crop output	.0012	.0005	2.43**
Sex	.0220	.0111	1.97*
Marital status	.0609	.04845	1.26
Goal of farming	.0500	.0201	2.48**
Constant	1.5770	.1795	8.78***
Prob > chi2	0.0000		
LR chi2(12)	34.74		
Log likelihood	-463.06483		
Pseudo R^2	0.3362		

Source: Field survey (2022)

Keys: *** = Significant at 1% level of probability
**=Significant at 5% level of probability
*=Significant at 10% level of probability

The coefficient for training received (.0950) was positive and statistically significant at 0.10 probability level. This implies cereal crop farmers who have access to training may likely leads to increase in the choice of adaptation strategies to land degradation. This is in line with *a priori* expectation because farmers who receive training on sustainable land management practices are likely to be more informed about the causes and consequences of land degradation, as well as the potential benefits of adopting sustainable practices (Bai *et al*., 2008). They may also have more access to information and resources that can help them implement these practices effectively

The coefficient for extension contact (.0440) was positive and statistically significant at 0.10 probability level. This implies that a unit increase in extension contact may likely leads to increase in the choice of adaptation strategies to land degradation. This is in line with the *a priori* expectation because extension services can provide technical assistance and support to farmers as they implement new technologies and practices (Bai *et al*., 2008). Extension agents also they played a key role in helping to increase the productivity and sustainability of agricultural system.

The coefficient for access to credit (.1066) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in credit access may likely increase the of choice of adaptation strategies to land degradation by the respondent. This is in line with the *a priori;* expectation as farmers have access to credit, they could be able to invest in new technologies and practices that will improve the productivity and sustainability of their land. This is in agreement with the study of Ogunmefun and Achike (2015) who reported that credit has positive relationship with adoption of soil conservative practices in Odogbolu Local Government Area of Ogun state.

The coefficient for crop output (.0012) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in crop output may likely increase the choice of adaptation strategies to land degradation by the respondent. This is in line with the *a priori;* expectation because farmers who are able to achieve higher yield are more likely to invest in sustainable land management practices, as they have more to gain from protecting their land and ensuring its productivity in the long term.

The coefficient for sex (.0220) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in number of males involved in cereal farming may likely increase the choice of adaptation strategies to land degradation by the respondents. The sex of a farmer could have an impact on the adoption of improved land management strategies this is because women farmers may be less likely to adopt new technologies and practices due to their lack of access to resources such as credit, extension services and education. Women may also face cultural and social barriers that prevent them from adopting new strategies.

The coefficient for goal of farming (.0500) was positive and statistically significant at 0.05 probability level. This implies that a unit increase in goal of farming may likely increase the choice of adaptation strategies to land degradation by the respondent. This is in line with the *a priori;* expectation because farmers who are commercialize oriented have a strong sense of purpose and are more likely to invest in sustainable land management practices, as they are motivated to ensure the long-term viability of their land and their livelihoods.

4.7 Test of Hypotheses

4.7.1 Hypothesis I

Hypothesis (i) stated as: "There is no significant relationship between selected socio economic characteristics (age, household, level of education, farming experience, sex and marital status) and the choice of adaptation strategies to mitigate the effects of land degradation in the study area. This was tested using the Z-value from the Poisson regression. As revealed in Table 4.10, age (.01385), level of education (.0926), and sex (.0220) were statistically significant at 0.01, 0.05 and 0.10 probability levels respectively. Therefore, the null hypothesis that says there is no significant relationship between the age, level of education, sex and the choice of adaptation strategies to mitigate the effects of land degradation was rejected, while the alternative hypothesis was accepted. More so, the null hypothesis based on household size, farming experience and marital status were accepted as they were not significant. The implication is that, most of the selected socio-economic variables play significant roles in the choice of adaptation strategies to mitigate the effects of land degradation as shown in Table 4.8.

Table 4.8: Estimate of Hypothesis I

Variables	Coefficient	t-values	Decision
Age	-.01385	-2.90***	Reject H_O
Household size	. 0031	0.54	Accept H_A
Level of education	.0926	3.26***	Reject H_O
Farming experience	-.0027	-0.49	Accept H_A
Sex	.0220	1.97*	Reject H_O
Marital status	.0609	1.26	Accept H_A

Source: Field survey (2022)

Keys: *** = Significant at 1% level of probability
**=Significant at 5% level of probability
*=Significant at 10% level of probability

4.7.2 Hypothesis II

There is no significant relationship between the perceived effects of land degradation on cereal crop production and effectiveness of the adaptation strategies adopted to mitigate effects of land degradation in the study area. The relationship between perception of the respondents on the effect of land degradation and effectiveness of the adaptation strategies adopted were tested using Pearson’s Product Moment Correlation (PPMC) and the result is presented in Table 4.9. The correlation (r) value of 0.1717 showed low positive relationships with the effectiveness of adaptation strategies. This implies that increase in perception of the respondents on the effects of land degradation will increase the effectiveness of the adaptation strategies by respondents in the study area. The findings of the study is inline with Nwachukwu (2012) who found that there is significant relationship between awareness campaign on the proper use of agricultural land and effective stakeholder participation in land use planning and management as shown in Table 4.9.

Table 4.9: Relationship between Perception of the Respondents on the Effect of Land Degradation and Effectiveness of the Adaptation Strategies

	Perception score	**Effectiveness**
Perception score effects	1.0000	
Effectiveness score	0.1717	1.0000

Source: Field survey (2022)

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings of the study, it was concluded that respondents were within their active productive age, married with large family size as well as fair education status and experienced cereal crop farmers. In addition, average respondents have access to credit while some of them were members of cooperative. The major forms of physical land degradation experienced by the respondents in the area were runoff, waterlogged and soil structure destruction while low nutrient availability and increase soil acidity were the major chemical land degradation experienced by cereal crop farmers in the study area.

The perceived effects of land degradation on cereals crop output were soil nutrients loss, occurrence of soil erosion, reduction of crop yield, increase labour supply, low output of farm produce and reduced in labour productivity. The land degradation adaptive strategies adopted by the respondents were terracing, mixed farming, organic manure, inorganic manure and afforestation.

The result of the factors that influence the choice of adaptation strategies to land degradation indicated that level of education, extension contact, access to credit and total output had direct influence on choice of adaptation strategies while age had inverse relationship with choice of adaptive strategies.

5.2 Recommendations

From the findings of the study, the following recommendations were drawn:

1. The study recommended that policymakers, community based association and other relevant stakeholders, should provide access to credit and financial resources for rural farmers to invest in sustainable land management practices

2. Government should encourage education and training programmes in land degradation and sustainable land management practices for farmers and rural communities
3. The policy makers should adopt bottom down policy so as to give adequate consideration to small scale farmers with large family size in the design and implementation of land degradation adaptation programs to ensure they are accessible and sustainable for them.
4. The cereal crop farmers should be sensitize by relevant stakeholders (Governmental and Non-Governmental Organization) on the effects of their activities on the land which deplete soil nutrients and train them on the best adaptive strategies for natural occurrences like flood

5.3 Contribution to Knowledge

The study revealed that runoff (89.87 %), waterlogged (78.85%) and soil structure destruction (75.33%) are the physical land degradation experienced by cereal crop farmers, while low nutrient availability (96.48%) and increase soil acidity (72.12%) are the major chemical land degradation experienced by cereal crop farmers in the study. As such, adaptation strategies need to be adopted by crops farmers to reduce the effects of land degradation on their crop production. The study also revealed that soil nutrients loss, occurrence of soil erosion and reduction of crop yield are the perceived effects of land degradation on cereals crop output. The correlation (r) value of 0.1717 showed low positive relationships with the effectiveness of adaptation strategies. To mitigate the effect of land degradation, mixed farming need to adopted because it helps increase the sustainability and productivity of the land over the long term. It helps to increase the fertility of the soil by incorporating animal manure and other organic matter into the soil.

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APPENDIX A

QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL EXTENSION & RURAL DEVELOPMENT
SCHOOL OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA

RESEARCH QUESTIONAIRE

Dear Respondent,

I am a Masters student of the above named institution currently undergoing research work titled: Perceive effects of land degradation on cereal crop production in rural areas of Niger State, Nigeria. This act is in partial fulfillment of the requirement for the award of MTECH CERTIFICATE. Please kindly supply the necessary information required to execute this study by answering the questions below. I assure you that all the information provided will be kept confidential and used strictly for academic purposes only.

Thank you for your anticipated co-operation and understanding.

MOHAMMED, Isah Kanko

MTech/SAAT/2018/7851

Date of interview __________ Time of interview_____________ Serial Number ______________

State __________ Local Gov't _________________ Community _____________

SECTION A: Socio-economic characteristics of respondents

1. Age...........................

2. Sex (a) Male ( ) (b) Female ( )

3. Marital Status: (a) Married ( ) (b) Single ( ) (c) Divorce ( ) (d) Widow ( )

4. Household size……………………..

5. Do you have any form of formal education? Yes ( ) No ( )

6. If yes, from below, please tick the level of formal education you have acquired:
(a) Primary (b) Secondary (c) Tertiary

7. What is your major source of farm labour?
(a) Family labour ( ) (b) Hired labour (c) both family and hired labour

8. For how long have you been into farming…………………..

9. What is your main goal for farming?
(a) family consumption ( ) (b) commercial purpose (c) both family consumption and commercial purpose

10. Do you have any access to extension services? Yes ( ) No ( )

11. If yes, how many times were you visited during the last cropping season (specify)……….

12. How many extension events/training concerning land degradation did you attended during the last cropping season? …………………….

13. Please indicate your sources of information on land degradation?

Sources	Regularly	Occasionally	Never

Extension Agents			
Family & Neighbours			
Television			
Radio			
Cooperative Societies			
Workshop & Seminars			
Print Media			

14. Do you belong to any cooperative society? Yes ( ) No ( )

15. If yes, how many cooperative society do you belong as a member (please specify)………………

16. If yes, how many years have you being a member? ………………….

17. What is your major source of capital for crop production?

(a) Self owned ( ) (b) Otherwise ( )

18. Did you apply for agricultural credit during the last cropping season (regardless of the institution) Yes ( ) No ( )

19. If yes, please tick from the following sources you received credit from:

(a)Thrift society (b) Friends (c) Commercial Banks (d) Bank of Agriculture (e) others--------------------

20. And, how much did you receive (please specify) #......................................

21. What is your annual farm income from crop production?

Type of Crops grown	**Total bags produced**	**Value in Kg**	**Cost per Kg**	**Total Income**
maize				
Rice				
sorghum				
millet				
Total				

22. How much do you earn annually from off-farm sources of income

Sources	**Amount Earned**
Civil Service	
Trading	
Hand craft	
Tailoring and fashion designing	

Saloon and hair dressing	
Transportation business	
Other sources	
Total Income Earned	

SECTION B: The forms of land degradation prevalent in the study area

Please provide information on the types of land degradation prevalent in the study area

23. Did you experience incidence of land degradation in your farm? Yes ( ) NO ( )
If yes please indicate (Tick) the types of land degradation you experience in you farm from the following.

Types of land degradation	**TICK**
Physical degradation	
Soil structure destruction	
Dispersion of soil particles	
Sealing of pores	
low infiltration	
Reduced root penetration	
Waterlogging	
Runoff	
Accelerated erosion	
Compression and increasing density	
Chemical degradation	
Low nutrient availability	
Low nutrient uptake	
High mobility of elements	
Present of toxic substances	
Increase soil acidity	
Salinity and sodicity	
High level of soil alkalinity	

SECTION C: The perceived effect of land degradation on cereal crop production

24. Please provide information on the perceived effect of land degradation on cereal crop production

Perceived effects	SA	A	U	D	SD
Occurrence of soil erosion which reduces soil fertility					
There is change of cropping practices over the years					
Recommended hybrid seeds are used during Cultivation					
Shifting cultivation has become less common					
Previously cultivated fields are abandoned due to poor soil fertility					
Farmer spends more resources on how to improve their land & check land degradation threats					
Low output of farm produce					
Reduces the income of the farmer					
Reduction in crop yield					
increase labour supply in the farm					

Reduction in land productivity					
Soil nutrient loss					

SA= strongly agree, A= agree, U= undecided, D= disagree, SD= strongly disagree.

SECTION D:
The adaptation strategies to land degradation employed by farmers in the study area

25. Please provide information **(TICK)** from the following adaptation strategies you adopted to check the effects of land degradation on your farm

Land degradation adaptation strategies	**(TICK)**
Crop rotation	
Mixed cropping with legumes	
Mixed farming	
Terracing	
Zero/no Tillage	
Fallowing	
Organic manure	
Inorganic or mineral fertilizer	
Inter-cropping with	
Combination of inorganic and organic fertilizer	
Afforestation	
Planting of grass	
Stone-line	

26. Please indicate the level of adoption of the adaptation strategies you employed above

Land degradation strategies	**AW**	**T**	**D**
Crop rotation			

Mixed cropping with legumes			
Mixed farming			
Terracing			
Zero/hoe Tillage			
Fallowing			
Organic manure and fertilizer			
Inorganic or mineral fertilizer			
Inter-cropping			
Use of organic fertilizer			
Afforestation			
Planting of grass			
Stone-line			

AW= Awareness T= trial, A= adoption

SECTION E

The level of effectiveness of the adaptation strategies to land degradation employed by farmers in the study

26. Please provide information on the level of effectiveness of the adaptation strategies to land degradation employed on your farm

Adaptation strategies employed	**VE**	**E**	**I**	**NE**	**NVE**
Crop rotation					
Mixed cropping with legumes					
Mixed farming					
Terracing					
Zero/hoe Tillage					
Organic manure and fertilizer					
Inorganic or mineral fertilizer					
Inter-cropping					

Use of organic fertilizer					
Afforestation					
Planting of grass					
Stone-line					

VE=very effective, E=effective, I=indifferent, NE=not effective and NVE=not very effective.

Thank you

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