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E-Agricultural Extension and Soil Conservation Practices: A Review of the Impact of E-Agricultural Extension Services on Soil Conservation Practices in Nigeria

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Abstract
This paper reviewed e-agricultural extension and soil conservation practices in Nigeria. In this review, an attempt was made to ascertain issues with conservation practices, promote the use of e-agriculture in extension , and improve the business of soil conservation proactively. E-agriculture was found to provide indirect impact, which support farmers with advance information about weather condition, increase efficient use of resources. Also, it provided opportunities to prevent soil loss, increase yields and saves water. However, it essentially requires timely and reliable sources of information for useful decision making. This paper showed that soil conservation practices are categorized into agronomic, soil management, and mechanical practices, aimed at preventing soil loss. This has made significant progress since then even though there are issues with some of the practices. Thus, it is concluded that there is poor adoption of soil conservation measures leading to land degradation in Nigeria. Mechanical practices have many harmful effects, including soil degradation. It could also be deduced that there is lack of enough skilled and scientific manpower to overcome soil loss in Nigeria. Therefore, it is recommended that farmers in Nigeria should be trained on appropriate conservation practice to avoid destruction of soil structure and there should be enough skilled and technical expertise in soil conservation practices.
Key words: E-Agriculture; Extension; Land; Management; Method; and Impact.

Introduction

According to Fugo *et al.* (2019) an estimated 75% of the world's poor and hungry live in rural areas and depend directly on agriculture for their livelihoods. Showole and Hashim (2019) express that low inherent soil fertility, soil erosion areas are major cause of poor agricultural performance. Thus, agriculture is essential to maintain life and one of the key components that provides food for people in rural areas. Naturally, one of the fundamental aims of agriculture is to have physical, social and economic access to sufficient, safe and nutritious food and create enabling environment for food to be produced sustainably. Effective sustainable agricultural development depends on useful exchange of information, ideas and knowledge. Furthermore, robust agricultural environments depend on adequate environmental monitoring, which is essential to gather information and assess the effectiveness of the environment. Environmental monitoring also provides an environment that allows the attainment of food security and food safety. According to Klimova *et al.* (2016) environmental monitoring initiative outcomes should include the investigation, assessment, and integration of adequate data and information, in order to decrease the risk of being exposed to contaminants, as well as to reduce and control uncertainty. Opara, (2013) reported that sensors, wireless sensors, and sensor networks, are fundamental components in environmental monitoring schemes, since they increase data availability. In accordance with Aqeel-ur-Rehman *et al.* (2014) effective sensor networks and wireless sensor networks that consist of numerous components, including mobile smart devices

for collecting application-oriented data are essential monitoring infrastructure for providing real-time information during agricultural environmental monitoring and can enhance agricultural environmental management strategies, especially soil conservation practices.

Accordingly, soil conservation is a key to economic growth because it can increase the quality and quantity of crop yields, facilitate crop growth and provide physical support for plants. So, fragile lands without sufficient use of conservation measures (soil cover), declining use of fallow, and limited replenishment of soil nutrients courses crop failure. According Showole and Hashim (2019) soil degradation are caused by both water and wind but, soil nutrient depletion is caused by overgrazing and deforestation.

According to Yu-Pin *et al.*(2017), agricultural environment generally manage various sources of data and information. Deepali (2013) stated that appropriate data cleaning and filtering approaches should combine these various data sources. Since the ability with which e-service agriculture deal with various data sets could be especially useful in environmental monitoring. It may help to conserve and protect natural resources. Therefore, E-Agriculture makes better management decisions, as an effective tool for facilitating data collection, validation, access, exploration, and communication. E-Agriculture in extension allows various stakeholders to assemble and share data concerning soil conservation, it also restores habitat for plants and animals, improves water quality, and makes soil healthier.

E-Agriculture

The concept of e-agriculture is a field interconnected alongside the use of modern information and communication medium and innovations that increase agricultural output and makes information accessible to extension, production, agricultural research, planning, monitoring, marketing, and trade services. According to Abdulai and Huftman (2014), e-agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use Information and Communication Technologies (ICTs) in the rural domain, with a primary focus on agriculture. E-agriculture is a global community practice, where farmers from all over the world exchange information, ideas, and resources for sustainable agriculture and rural development(Opara, 2013). Deepali (2013) defined e-agriculture as the extension over a global domain within the information environment consisting of the interdependent network of information system. But, it applied context of agriculture, using the power of online networks, computer communication and digital interactive multi-media to facilitate dissemination of agricultural innovations. The major e-agricultural tools include personal computers, mobile phones, radio, television and other telecommunication devices. Some mobile technologies in e-agriculture include Mobile phones, Global Positioning System (GPS), Barcode Scanners, RFID (Radio Frequency Identification) readers, and Smart card readers. All these are some of the examples of technologies that can be used to capture, read and store data. However, further components such as the Internet, communication networks and regulatory agency systems (to provide data security and standards systems) are important (Temitope and Lloyd,2021). According to Kala (2017) E-agriculture is not yet fully known to all farmers in Nigeria. But, it has potentials to make farmers' life better and advance the economy faster.

E-Agricultural Extension

According to FAO (2005), E-agricultural extension is the agricultural services, innovations, and information dissemination or delivered through the Internet and related technologies. As also stated by FAO (2016), e-agriculture is a widely established field focusing on the improvement of

agricultural and rural development through useful Information and Communication Technologies. Salako *et al.* (2006) stated that e-agriculture refers to Information and Communication Technologies (ICTs) in agriculture. The circumstances that form the setting of E-agriculture were categorized into direct contribution and indirect contribution.

Direct Contribution

is the direct impact contribution of agriculture technology for farm productivity called Precision agriculture (PA)(Mulla, 2013).According to NRC (1997),PA is the application of modern information technologies to provide process and analyze multisource data of high spatial and temporal resolution for decision making and operations in the management of crop production. Prachi and Yangson (2020) reported that PA is the science of improving crops yields and assisting management decisions using high technology sensor and analytical tools. It is a new concept adopted throughout the world to increase production, reduce labour time, and ensure effective management of fertilizer and irrigation processes. It uses large amount of data and information to improve the use of agricultural resource, yield, and quality of crops (Mulla, 2013).Therefore, the overall aim of PA is for crops and soils to receive accurate nutrients for optimum growth and productivity.

Indirect Contribution

According to Havinal (2020), indirect contribution is the provision of relevant information, facilitating an environment for more lucrative agriculture. By facilitating access to markets via functional information on markets prices, regional forecasts, and all necessary information on crop production. The indirect contribution supports the farmers in decision making and involves them in agricultural development. Thus, makes farmers to take informed and quality decision, which have positive impacton the way agriculture and allied activities, are conducted. Urgently, it requires timely and reliable sources of information for taking decision, and this makes information not merely useful, but necessary to remain competitive. In Nigeria, few farmers more especially educated ones depend services delivered through the Internet and related technologies to take decision based on facts. In that regard, farmers need to be aware of usefulness of informed decision.

Conservation

Conservation is an idea that has been broadly defined as prolonging the useful life of resources (Manale *et al.,* 2018). In accordance with Kala (2017), the concept of conservation is a careful preservation, protection and management of natural resources to prevent exploitation or destruction. The ideas is said to be aimless except farmers are engaged by taking action toward the long-term preservation of natural resources for future generations. The objective of land conservation is to increase agricultural productivity in sustained manner without deteriorating the soil health (Darzi-Nafchali and Karandish, 2019).

Soil Conservation Practices

Soil Conservation is the action of stopping and lessen the quantity of soil lost through erosion (Manale *et al.,* 2018).Soil conservation is a combination of all methods of management and land use that safeguard the soil against depletion or deterioration by natural or man-induced factors (Kala, 2017).Soil conservation practices are those farming operations and management strategies conducted with the goal to control soil erosion by preventing or limiting soil particle detachment

and transport in water or air (Junge *et a.,* 2008). The outlook of Kammer (2014), suggested that soil conservation practices is the adoption of many practices aimed at improving soil productivity and crop yield. Soil conservation has been described as the positive task of devising and implementing systems of land use and management so that there shall be no loss of stability, or usefulness for the chosen purpose (George, 2018).Soil conservation practices seeks to increase the amount of water seeping into the soil, reducing the speed and amount of water running off (Baumhardt and Blanco-Canqui, 2014). In this regard, soil conservation practices can be considered to be tools that farmers can use to prevent soil degradation, which maintain the fertility and soil structure. According to Junge *et al.* (2018) soil conservation practices are mainly categorized into: agronomic practices; soil management practice: and mechanical practices.

Agronomic Practices

Agronomic practices is a soil conservation practice which involve the application of mulching and crop management simultaneously, use the effect of surface covers to reduce erosion by water and wind (Morgan, 1995). Therefore, agronomic practices are said to be the combination of mulching and crop management practices concurrently to prevent soil particle loss from raindrop detachment and wind storm.

Mulching

According to Lal (2001) the process of covering the soil by a layer of various external materials is called mulching and the materials used for covering is called mulch. As stated by Adekalu *et al*. (2006), mulch result in reducing the raindrop impact, decreasing the speed of draining away of water, and hence reducing the amount of soil erosion. Hence, soil loss can be prevented or reduce by placing different types of materials such as decaying leaves, shrubs, farmyard manure, bark, or compost spread around the soil, which may help to retain more soil moisture. So, mulching is an essential strategy for soil conservation. However, when applied too thickly it can result in overheating the soil and starve it of light penetration and water percolation.

Crop Management

Soil erosion can be put to stop to certain extent from further loss by suitable crop management, which may be growing two or more crops all-at-once in the same field during a single growing season. A plant that is used primarily to slow soil erosion or improve soil health and leaving a trace spaces amongst plants when planting. The high density planting stops splash of rain from detaching soil particles and this keeps soil erosion to tolerable limits. Accordingly, cover crops play an important role in soil conservation hence the suggestion of Junge *et al.* (2018) that crop management can be categorized into use of cover crops, improved fallows, multiple cropping, intercropping and strict adherence to planting time.

Cover crop

Cover crops such as the legumes *P. phaseoloides*, and M. *pruriens*, or the grasses such as *Pennisetum purpureum*, and *Paspalum notatum* are plants that grow rapidly and close (Lal, 2001). Their dense canopy prevents dislodgment of soil particles by erosive forces of rain drop and surface flow of water. And this keeps soil loss to some extent from degradation (George, 2018). Cover crop is costly for commercial farmers and increase insect pests and disease. So, right cover crops should be chosen and be planted at the appropriate time.

Improved fallows

These are soil agroforestry techniques consisting of planting legume tree and shrub species in rotation with cultivated crops (Kala, 2017).Improved fallows of short periods with selected legumes and/or shrub species remain important as the long fallow periods that were part of the traditional system of practice for improving soil fertility are no longer common in many parts of Nigeria. This could be due to land availability for cultivation that is declining and there is no enough land to leave a sufficient period of fallow.

Multiple cropping

it is a common soil conversation practice in tropical and subtropical agriculture, which involves harvesting more than once a year (Xiao-Yan, 2000).It is a soil conservation strategy which has been traditionally practiced and is still being practice in Nigeria(Morgan, 1995). Showole and Hashim (2019) stated that there are basically three main types of multiple cropping as follows: Monoculture (it is the growing of the same crop in the same field in a year); Duo culture (two types of crops are grown alternatively every year on a piece of land) and Poly culture (it combines more than two types of crops grown in a sequence on a piece of land in a year). In multiple cropping, pests can comfortably move from crop to another which makes pests existence become easy. Also, spraying pesticides to individual crops is difficult. Thus, monoculture type of multiple cropping can be more suitable as a tool for soil conservation than Duo culture and Poly culture types of multiple cropping.

Intercropping

This system includes different kinds of annual crops planted in alternating rows to reduce soil erosion risk by providing better canopy cover than sole crops (Morgan 1995). According to Manale *et al.,* (2018),intercropping involves cultivating two or more crops in a field simultaneously. Intercropping is the growing of two or more crops next to each other at the same time. Under this cropping system, yield may decrease as the crops differ in their competitive abilities(Manale *et al* 2018). As this being the case, it is essential not having crops competing with each other for nutrient, water, space, or sunlight. Selected crops should be planted to achieve the overall aim of soil conservation.

Planting date

As reported by Junge *et al.* (2008), timing of planting of crops at a certain time or at close spacing, provides a higher canopy during periods with high rainfall intensities and hence protect the soil loss from raindrop or running off water. Thus, planting date plays an important role in soil conservation.

Soil Management practice

Soil conservation as stated by Kammer (2014) involves action by land managers that affect soil quality and productivity and alter soil's effect on crop yield which is mainly conservation tillage**.**

Conservation tillage

is any soil cultivation that leaves the previous year's crop residue *in situ* with the aim of conserving soil structure (Lal, 2001).Conservation tillage is any tillage and planting that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil loss which includes reduced tillage, Slot planting, strip tillage, and mulch tillage (Kammer, 2014). And

further stated that conservation tillage lead to increased runoff and increased agrichemical and nutrient losses.

Reduced tillage (Minimum Tillage)
Refers to growing a crop using only that tillage needed for placing the seed at proper depth and then covering them with thin layer of soil, aimed at controlling soil loss (Tejwani, 2004). Minimum tillage describes a practice where soil preparation is reduced to the minimum necessary for crop production and where 15% to 25% of residues remain on the soil surface (Morgan 1995). Reduced tillage plays an important role in soil conservation, however causes poor soil aeration.

Slot planting (No tillage or zero tillage)
Is the system of planting crops into untilled soil by opening a narrow slot or trench only of sufficient width and depth to obtain proper seed coverage (Temitope and Lloyd, 2021). According to Morgan (1995), slot tillage is a system of farming in which the seed are deposited into untilled soil which has retained the previous crop residues. (.The issue with slot planting is that farmers have no mechanical control over the weed. So, farmers are increasingly using chemicals to control the weed.

Ridge Tillage (including no-till on ridges)
According to ISWCR, (2015), ridge tillage involves planting crops in rows either along both sides or on top of the ridges which are prepared at the commencement of the cropping season.
Abdulai and Huftman (2014) reported that ridge-till presupposes planting the seeds in the valleys, between moulded ridges. The residues from the previous crop are cleared by farmers off ridge-tops. Furthermore, they place the residues into adjacent furrows to make room for the new crop planted on the ridges, which reduced soil loss. However, this technique may destroy soil structure by burying surface residues, and increasing evaporation from the tilled zone.

Strip tillage (zone tillage)
As stated by Adekalu, *et al* (2006), strip tillage is one method practiced for cultivating soil under non-inversion tillage techniques that conserves soil moisture and uses crop residue to protect against soil erosion and increase the environmental benefits for crop production. Strip tillage minimizes soil disturbance and keeps 75 percent of residue on soil surface.

Mulch tillage
Is a system of tillage in which organic residues are not inverted into the soil such that they remain on the surface as a protector cover against erosion. This soil conservation system is not appropriate for soft soil (Salako, 2006). Hence, it is better suited to heavier soils, high crop residues, cover crops, plow downs, and additions of organic amendments such as manure and compost.

Mechanical Practices
According to Adekalu (2006), mechanical practice is an engineering method of controlling and preventing soil erosion on agricultural lands. Mechanical methods for soil conservation are: basin leaching; pan breaking; sub soiling; contour terracing; contour trenching; terrace outlets; gully control; ponds and reservoirs; and stream bank protection.

Basin leaching

A drainage pit with sand and gravel on the sides constructed to allow water to dissipate (ISWCR 2015).In this method, a number of small basins (water reservoirs) are made along the contour by means of an implement called basin blister. Basins collect and retain rain water for long period and also catch and stabilize downwardly moving soils of the slopes. Basin leaching prevents soil loss and improves soil nutrients. However, when leaching eliminates too much nitrate from the soil, the pH decreases too much and the soil becomes over-acidic. Soil acidification in itself has many harmful effects, including soil degradation.

Pan breaking

In some areas, soils become impervious to water and are less productive because of formation of hard sheet of clay a few feet below the surface. Such areas can be made productive and water permeable by breaking hard clay pans by means of pan breaker on contour at a distance of about 5 feetas stated by Havinal (2020). By pan breaking, drainage and percolation of rain water is improved and soil is saved from residual run-off and erosion.

Sub-soiling

This is a method of cutting and opening the soil with a sub-soiler plow most often to break hard pans and reduce compaction according to (Adekalu2006). The sub-soiler can plough as deep as about 2 feet into the soil Mulla (2013). In this method, hard subsoil is broken deeply by means of an implement called sub-soiler. This process conserves soil and promotes absorption of rain water in the soil and makes the soil loose and fit to allow luxuriant growth of vegetation. However, sub-soiling loosens the soil, which makes it prone to erosion.

Contour terracing

According to Tejwani (2004),contour terracing is a farming practice that involves the ridge making across the slope of the land. This short step along the contours of the land is to prevent the rapid flow of water down the slope. Sometimes drainage channels or ridges are formed along the contours to retain water in the soil and to check soil erosion. Thus, terraces are levelled areas constructed at right angles to the slope to reduce soil erosion. Contour terracing improves soil erosion control however it requires large capital for building terraces and time to maintain the terraces. According to Chuxion *et al.* (2021),contour terracing may be of the following four types:

Channel terracing

These are the series of broad channels and embankments constructed at a suitable spacing along where?(Salako, 2006).This is concerned with making of wide but shallow channels on contours at suitable distance. In this process, the excavated soil is deposited along the lower edge of channel in the form of low ridge.

Narrow based ridge terracing

This process is commonly called bounding. In this technique, a number of narrow based ridges or bunds are constructed at distance of 1 – 2inches across the slope along the contour.

Broad-based ridge terracing

In this, wide but low bunds are made on contour by excavating soils from both the sides of ridge.

Bench terracing

This method involves making of wide step like platforms, the so called bench terraces, having suitable drops along contours. Along the outer edges of bench terraces bunds of about one foot height are raised to check the downward flow of rain water and also soil erosion. The vertical drops may vary from 1into 2m. Bench terracing is a very costly process and so it should be applied in areas where there is scarcity of arable land. . It is an expensive method of reducing soil erosion since it requires moving soil to construct the levelled areas, protecting the steep areas between terraces and constant repair and maintenance. Many factors such as length, the steepness of slopes, type of soil, and amount of precipitation may determine the feasibility of terracing.

Contour Trenching

Are ditches dug along a hillside in such a way that they allow a contour and run perpendicular to the flow of water (Chuxion *et al.* 2021). This method involves making a series of trenches across the slope at convenient distance (Tejwani, 2004). The soil excavated from the trenches is deposited along the lower edge in the form of bund. On the ridges, tree seeds could be sown.

Terrace outlet

In order to prevent soil loss and to discharge overabundance of rain water carefully from the contour terraces, pipe outlets are used which are densely enclosed by grasses.

Gully control

Is the process of making boundary around gullies or confines the gorge to prevent flow of water through it or by growing suitable soil-binding vegetation on the gullies to reduce soil loss and diversion trenches should be made around the ravine.

Ponds and reservoirs

Small pools and water dams should also be made at suitable places for irrigation and some other purposes. Various types of pools and dams have been devised to arrest and prevent ravine and thus reduce soil erosion. These dams may be brush dams, earth dams, and concrete dams.

Stream bank protection

Is the process of placing material along a bank of a watercourse for the purpose of erosion control (Kala, 2017). Banks of ravines and rivers with high vertical drops are subjected to heavy soil erosion. The bank erosions can be checked by making the drop sloppy and by growing vegetation on the slopes or by constructing stone or concrete pitch.

Impact of E-agricultural Extension on Soil Conservation

Technology have considerably improves agriculture at all times from the invention of the plow to the global positioning system (GPS) digital farming equipment, which makes farming food safety and grow more food. As stated by Oladotun and Rafiu (2019), most farmers in developing countries lack access to consistent, reliable information for many of their needs and often rely on a combination of these varied but inconsistent sources, plus traditional knowledge, experience and estimates, when making decisions. However, with the emergence of E-agricultural extension services which are accessible, in every nooks and crannies helps to reduce information gap in order to increase food production, by taking action to control soil erosion. E-Agricultural

Extension brings information regarding early warning and management of environmental erosion, Soil testing and soil sampling, so that farmers can take preventive measures to replenish the degraded land. Hence, E-AE helps in overcoming challenges in agricultural development, the effect of that is increase in farmers' wealth and food production. Thus, farmers have the opportunity of awareness, education and advanced information about weather condition and this prevent soil loss. In Nigeria, shortage of food, increase in cost of production, decrease in farmer income, decrease in market turnover and others are the effects caused by improper utilization of E-agriculture in managing soil conservation (Oladotun and Rafiu, 2019).

An overview of extension service in soil conservation practice

It is acknowledge that the operations of soil conservation practices demands an extension agent with technical expertise in soil conservation practice, and in effect this expertise is certainly not obtainable in an extension system. Thus, on account of that, there is a need to have a separate soil conservation department. As a short-lived measure, extension agents should be intensively subjected to frequent training on soil conservation, prior to the establishment of the department. Nevertheless, soil conservation plan of action will not be successful in producing a desired result without the understanding, and favourable cooperation of the farmers. It will be important that an extension agent should notify the farmers the overall aim of soil conservation is to maintain the fertility and structure of the soil, and the need and purpose of each soil conservation practice and the outcome intended to achieve. Extension's role in promoting soil conservation in Nigeria has a long history working with other agencies of government and private organizations to conserve soil. The extension system is not adequately undertaking a major educational role in the conservation of soil. Most farmers are not aware of the Extension education programs that teach landowners, farm operators, planners and government officials how to use soil for land management decisions. The long-term aim of generating awareness and educating the farmers about active process of implementing and managing preferred system of land use is to boost production. According to Fungo *et al.* (2019), methods for promulgating information on soil conservation may be through some of the following: use of the mass media to create general awareness (Phone, TV, Radio); use of especially prepared simple literature (e. g. the comics of the Soil Conservation Society in America); introduction of conservation topics into the school curriculum; and use of youth organizations such as Young Farmers etc.

Conclusion

Based on this review, it is concluded that the extension system in Nigeria is not adequately undertaking a major educational role in the conservation of soil and farmers are associate with the application local knowledge systems for soil conservation practices. It is also deduced that the extension education programs that teaches landowners and farm operators is not yet fully utilizes E-agricultural extension services in promoting soil conservation.

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