Soil and Water Conservation Practices in Nigeria: A Review

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Abstract

"Soil and Water Conservation practice" is a broad subject having global and national dimensions. Even though these practices cut across international boundaries, this paper has Nigeria in focus. Soil and water conservation is concerned basically with any practice that reduces soil erosion and water runoff, thus conserving soil. The soil needs to be conserved because it is the material medium for plant growth. On these soils depend agriculture and related primary production activities. The two types of practices for soil and water conservation in Nigeria are: mechanical (engineering, otherwise known as structural), and biological measures. Mechanical measures are permanent and semi-permanent structures which include terracing, bunding ,trenching, gabion structures, loose/stone boulders, check dams, crib wall, etc. Biological (otherwise known as agronomic or agricultural and agroforestry) measures are the vegetative measures which include forestry, agroforestry, horticulture and agricultural/agronomic practices This article seeks to review the level of application of the above-named conservation practices in Nigeria. It is intended to create awareness of the various governmental and non-governmental structures and mechanisms that have been developed to implement sound soil and water conservation programs in Nigeria. It is believed that this article will serve as a basis for current and future planning of soil and water conservation needs in both research and action programs for the sustenance of the nation's natural resources.

Keywords*: Soil and water conservation, Land Degradation, natural resources, Nigeria*

1. Introduction

The natural resources on which the practice of agriculture is based are soil, water and air. According to [1], soil and water conservation can simply be defined as any practice that reduces soil erosion and water runoff, thus conserving soil. One of the important roles of Agricultural Engineering is to ensure an optimum management of these resources (soil and water). This will ensure that these resources are conserved.

The soil needs to be conserved because it is the material medium for plant growth. On these soils depend agriculture and related primary production activities. It comprises of mineral and organic matter. Nature takes between 300-1000 years to build 2.5cm of soil [2], while a very intensive rainfall event can result in the loss of tonnes of soil. This makes soil resources a subject of importance in the drive towards natural resources conservation in the country. Efficient and profitable crop production hinges upon achieving a conducive soil environment capable of retaining adequate soil nutrient and moisture for sustained seed development and growth. It is therefore not an overstatement to say that because of the role the soil plays in sustaining plant and animal life, our very existence depends on the conservation of this all important natural resource base [3].

If soil and water resources are used without conservation, then one day, the resources will deplete to a point where they can no longer support plant and animal life. Soil and Water Engineering option in Agricultural Engineering ensures that soil and water are conserved and reclaimed where necessary. Agricultural Engineering practices such as conservation, tillage, terracing, erosion control, etc. are used for soil and water conservation. These are practiced by

Agricultural Engineers in many institutions in Nigeria including the River Basin Development Authorities and Agricultural Development Projects [4].

Land degradation was a significant global issue during the 20th century and remains of high importance in the 21st century as it affects the environment, agronomic productivity, food security, and quality of life [5]. Soil degradative processes include the loss of topsoil by the action of water or wind, chemical deterioration such as nutrient depletion, physical degradation such as compaction, and biological deterioration of natural resources including the reduction of soil biodiversity [6]. Loss of soil quality due to soil erosion remains a major factor of low crop productivity in tropical and subtropical countries.

Soil and water conservation (SWC) efforts should therefore be geared toward soil erosion control for enhanced maintenance of soil organic matter and soil physicalproperties. The main factors causing soil erosioncan be divided into three groups: (1) energyfactors, e.g., rainfall erosivity; (2) protection factors, e.g., plant cover and land management; and (3) resistance factors, e.g., soil erodibility. This entry mainly covers soil erosion by water. Soil erosion is a major threat to the soil resource, soil fertility, productivity, and, lastly, to food and fiber production [7]. According to [8], soil erosion is the biggest environmental problem the world faces second only to population growth. Worldwide, erosion on cropland averages to about 30 t/ha/year, and each year about 10 million ha of cropland is rendered unproductive and abandoned due to soil erosion [9].

In Nigeria, West Africa, human-induced soil degradation is a common phenomenon. Its severity is light for 37.5% of the area (342,917 km^2), moderate for 4.3% (39,440 km^2), high for 26.3% (240,495 km^2), and very high for 27.9% (255,167 km^2). Soil erosion is the most widespread type of soil degradation in the country and has been recognized for a long time as a serious problem. In 1989, 693,000 km^2 were already characterized by runoff-induced soil loss in the south and 231,000 km^2 were degraded, mainly by wind erosion, in the north. Sheet erosion dominates all over the country, whereas rill and gully erosion are common in the eastern part and along rivers in northern Nigeria [10, 11].

Structural measuresof SWC in croplands often aim at changing the slope profile and are primarily constructed to control runoff and soil erosion. Their construction usuallyinvolves earth movements and requires substantial initial inputs of labor or money. These structures are often located along the contour and in marginal rainfall areas where rainfall needs to be conserved on-site. The appropriate type of physical structure depends on climate and need to retain or discard the runoff, farm sizes, soil characteristics (texture, drainage, and depth), availability of an outlet or waterway, labor availability and cost, and the adequacy of existing agronomic of vegetative conservation measures [1].

2. Study Area Description

Nigeria is located between Latitudes 4° and 14° N and Longitudes 3° and 15°E on the Gulf of Guinea with a land mass of 923,768 km^2, signifying about 14% of the West African landed area. Approximately, 13,000 km^2 (1.4%) of the land is covered by water and the remaining 98.6% ranges from thick mangrove forests and dense rainforests in the south to a near-desert condition in the north-eastern part of the country. Additionally, the country has a coastline of over 853 km with about 80% in the Niger Delta region. The country is adjoined by four countries including the Republic of Benin in the West, Niger and Chad Republic in the North, the Cameroon Republic in the East, while the Atlantic Ocean forms the southern limits of the territory. There are three distinct ecological zones in the country including Guinea savannah, Northern Sudan Savannah and Southern rainforest [12].

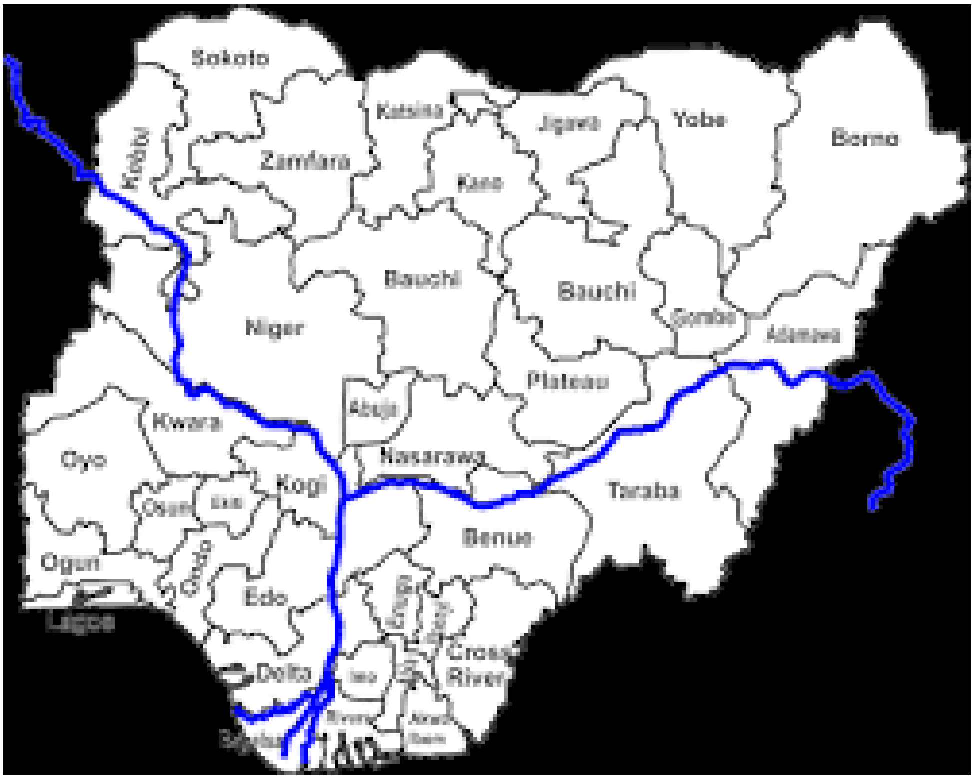

Figure 1: Map of Nigeria, showing the 36 states

The climate in Nigeria is characterized by relatively high temperature and variations in the amount of precipitation throughout the year with alternating two seasons (rainy and dry). The rainyseason is generally from April to October and the dry seasonfrom November to March, with some degrees of spatial and temporal variations in the amount and distribution of rainfall across the agro-ecological zones. The southern partof the country has the highest average annual rainfall, ranging from 1524 to 2035 mm with duration of eight to nine months. The middle belt ranges from 508 to 1524 mm while it is less than 508 mm annually for a period of five to six months in the north and less than four months in the far north [13].

Furthermore, a short dry season is knownas "August break" generally comes up in the month of August. The dry season persists from late October to early March. This period witnesses dusty north-east winds. However, the Northern Nigeria which experiences short wet season, the dry season is very long, from October to mid-May. Annually, the average temperature ranges from 21 to 32°C in the south while the north has a temperature range of 13 to 41°C. Nigeria, the most populous country in Africa, was estimated to have a population of over 140 million in 2006 and the United Nation estimate in 2015 was roughly 181 million. However, the exponential projection growth in the population has not translated to food sufficiency but rather the agricultural production is on the decline. There is an uneven spatial population distribution with about 65% living in rural areasand the rest in urban areas [14].

According to various researchers, there are a number of reasons why water and not land may be the most important constraint for Nigeria's agricultural production. First, is Nigeria's extreme inter and intra annual climate variability. Second, is the strong indication that discharges from the West African rivers including Nigeria have dropped significantly over the past 25 years. Third, the population growth and growing urbanization is increasing water demand for domestic, industrial and environmental uses.

3. History of Soil Conservation Practices in Nigeria

In Sub-Sahara Africa, soil conservation has a long tradition. Indigenous techniques from the pre-colonial era focused on erosion control in combination with water conservation by ridging, mulching, constructing earth bunds and terraces, multiple cropping, fallowing, and the planting of trees [15, 16]. In colonial times, the British Government worked on natural resource management as interest was high in expanding commercial farming enterprises. [17] wrote the earliest article on soil conservation practiced in northern Nigeria, and [18] recorded the implementation of terraces in several areas on the Jos Plateau in former times.

Large-scale projects on soil loss control were started [19], especially in areas of high agricultural potential, but many of them failed as the imported technologies had little relevance in the tropics and were not adopted later by local farmers. After independence in 1960, more emphasis was put on soil fertility issues. Decreasing funds at the end of the oil boom in the 1980s additionally restricted the performance of soil conservation schemes. Today, the seriousness of this environmental problem still exists and is also recognized by the Federal Government of Nigeria that planned to spend about half a million US dollars on soil erosion projects all over the country in 2007 [20].

4 Soil Conservation Practices in Nigeria

Conservation serves to reduce soil degradation. Various processes and practices resulting from agricultural and non-agricultural practices cause soil degradation, among which are soil erosion, soil toxicity, soil pollution and depletion of soil nutrients [3]. There are two types of practices for soil and water conservation, namely, (i) mechanical (engineering, otherwise known as structural) measures and biological measures. Mechanical measures are permanent and semi-permanent structures which include terracing, bunding, trenching, gabion structures, loose/stone boulders, check dams, crib wall, etc., (ii)biological (agronomic otherwise known as agricultural and agroforestry) measures are the vegetative measures which include forestry, agroforestry, horticulture and agricultural/agronomic practices [21].

Nigeria has a wide diversity of soils under different ecological conditions and with different levels of fertility. The traditional land tenure system and soils management practices involving shifting cultivation, slash-and –burn processes and traditional tillage method ensure the maintenance of soil physical properties and the sustainability of productivity. However, land use pressure has reduced the duration of fallow to restore soil fertility below the recommended minimum threshold required for sustainability.Many indigenous conservation methods such as ridging, terracing, multiple cropping and fallowing were used in the pre-colonial era [15]. In the colonial times, the British Government conducted large-scale projects in soil conservation but many failed as imported technologies were inadequate. Soil fertility issues gained more emphasis after independence. Decreasing funds at the end of the oil boom in the 1980s however restricted soil conservation schemed [22]. According to a study by scholars including Pimentel *et al.*, 1995; Uri ND, 2000, Worldwide, around US$ 400 billion annual cost of on- and -off-site erosion has been estimated for replenishing lost nutrients, cleaning of water reservoirs and conveyances, and preventing erosion[23].

Contour Farming

Contour farming is one of the most commonly used agronomic measures for soil and water conservation in hilly agro-ecosystems and sloppy lands. All the agricultural operations viz. plowing, sowing, inter-culture, etc., are practiced along the contour line. The ridges and furrows formed across the slope build a continual series of small barriers to the flowing water which reduces the velocity of runoff and thus reduces soil erosion and nutrient loss [24, 25]. It conserves soil moisture in low rainfall areas due to increased infiltration rate and time of concentration, while in high rainfall areas, it reduces the soil loss. In both situations, it reduces soil erosion, conserves soil fertility and moisture, and thus improves overall crop productivity. However, the effectiveness of this practice depends upon rainfall intensity, soil type, and topography of a particular locality.

Conservation Tillage

In this practice at least 30% of soil surface should remain covered with crop residue before and after planting the next crop to reduce soil erosion and runoff, as well as other benefits such as C sequestration. This term includes reduced tillage, minimum tillage, no-till, direct drill, mulch tillage, stubble-mulch farming, trash farming, strip tillage, etc. The concept of conservation tillage is widely accepted in large scale mechanized crop production systems to reduce the erosive impact of raindrops and to conserve the soil moisture with the maintenance of soil organic carbon. Conservation tillage improves the infiltration rate and reduces runoff and evaporation losses [26]. It also improves soil health, organic matter, soil structure, productivity, soil fertility, and nutrient cycling and reduces soil compaction.

Minimum tillage or zero tillage is an appropriate soil conservation technology in Nigeria as it reduces erodibility [27, 3]. This form of conservation tillage results in long-term maintenance of the soil structure and an increase in water retention and hydraulic conductivity. Zero-tillage practice is however not applicable to stem tubers and root crops which are usually planted on ridges. Contour ridging are mechanical measures common all over Nigeria, while tied ridging are common in the northern part of the country [28]. Permanent erosion control technologies such as terraces were built in Maku near Nsukka [15].

Crop Rotation

Crop rotation is the practice of growing different types of crops in succession on the same field to get maximum profit from the least investment without impairing the soil fertility. Monocropping results in exhaustion of soil nutrients and deplete soil fertility. The inclusion of legume crops in crop rotation reduces soil erosion, restores soil fertility, and conserves soil and water [29]. Further, the incorporation of crop residue improves organic matter content, soil health, and reduces water pollution. A suitable rotation with high canopy cover crops helps in sustaining soil fertility; suppresses weed growth, decreases pests and disease infestation, increases input use efficiency, and system productivity while reducing the soil erosion [30].

Agroforestry

Agroforestry practices combine the use of agricultural crops and/or animals with trees/shrubson the same land .Agroforestry, or alley farming, is another alternative strategy to the slash-and-burn system. It is an erosion control that involves the cultivation of annual crops within hedge-rows formed by leguminous trees and shrubs such as acacia. These legumes help in nitrogen fixation, enhance nutrient cycling through their deep roots, provide biomass for use as mulch and fodder for livestock, as well as improve soil organic matter and sustain crop yield under continuous cropping. It was introduced in Nigeria in 1980, initially to the South east and later to the SouthWest. Field trials show that trees improve the soil structure and maintain a high infiltration rate which reduces runoff. Reasons adduced for adoption and continued usage include soil fertility improvement, production of staking material and poles, fuel wood, reduction of fallow length, feed for animals and erosion control [3].

Mulching

Mulch is any organic or non-organic material that is used to cover the soil surface to protect the soil from being eroded away, reduce evaporation, increase infiltration, regulate soil temperature, improve soil structure, and thereby conserve soil moisture [31,32]. Mulching prevents the formation of hard crust after each rain. The use of blade harrows between rows or inter-culture operations creates "dust mulch" on the soil surface by breaking the continuity of capillary tubes of soil moisture and reduces evaporation losses. Mulching also reduces the weed infestation along with the benefits of moisture conservation and soil fertility improvement. Hence, it can be used in high rainfall regions for decreasing soil and water loss, and in low rainfall regions for soil moisture conservation. Organic mulches improve organic matter and consecutively improving the water holding capacity, macro and micro fauna biodiversity, their activity, and fertility of the soil [33, 34].

Cover Crops

The use of cover crops improves soil structure, increases nitrogen level, and acts as weed smotherers. Examples of cover crops include *Puerariamucuna*. They can be planted in pure pure stands on an uncultivated piece of degraded land or in association as a relay with an annual crop such as maize. [35] cited additional advantages of *Mucuna* to include increased crop yield, the ability to suppress weeds such as spear grass (*Imperatacylindrica*), thus reducing the arduous task of weeding, provide livestock feed and income for adopters through the sale of seeds.

Organic Matter and Fertilizer Management

Adding manure and fertilizers to the soil supplies the plant nutrient for vigorous crop growth. The elevated nutrient levels boost crop growth, thus covering the ground quickly, protecting it from erosion, and allowing water to seep in [1].

Strip Cropping

Growing alternate strips of erosion permitting and erosion resistant crops with a deep root system and high canopy density in the same field is known as strip cropping. This practice reduces the runoff velocity and checks erosion processes and nutrients loss from the field [36, 37]. The erosion resisting crops protects soil from beating action of raindrops, reduces runoff velocity, and thereby increased time of concentration which results in a higher volume of soil moisture and increased crop production [26]. Strip cropping is practiced for controlling the run-off and erosion and thereby maintaining soil fertility.

Intercropping

Cultivation of two or more crops simultaneously in the same field with definite or alternate row pattern is known as intercropping. It may be classified as row, strip, and relay intercropping as per the crops, soil type, topography, and climatic conditions. Intercropping involves both time-based and spatial dimensions. Erosion permitting and resisting crops should be intercropped with each other. The crops should have different rooting patterns. Intercropping provides better coverage on the soil surface, reduces the direct impact of raindrops, and protects soil from erosion [36, 29].

Mechanical Methods of Soil Conservation

Mechanical methods, including bunds, terraces, waterways, and structures such as vegetative barriers or stone lines installed on farm also can break the force of winds or decrease the velocity of runoff to reduce soil erosion [38]. Contour bunds made of earth or stones or terraces that consist of an excavated channel and a bank or ridge on the downhill side for cultivating crops are permanent erosion control technologies [38, 39]. The first are installed across slopes of low gradients, the latter at right angles to the steepest slope in hilly areas. Research on contour banks was conducted by [40], who considered these measures to be useful to prevent gully erosion, the most spectacular type of erosion. He also prepared an implementation guide for farmers including the description of the design and construction of graded contour banks.

Field trials on terraces made by [39] in Ibadan showed that the mean soil loss from a catchment without any erosion control measures was 2.3 t ha^{-1} and from a terraced catchment, 0.7 t ha^{-1}. Terraces were also built in Mokwa [41], in the Pankshin area on the Jos Plateau [18], and at Maku near Udi-Nsukka [15]. The records state that permanent structures of these kinds are effective soil conservation technologies as excessive soil loss and silting up of the fields are reduced. However, high labor intensity, time-consuming regular inspections, high consumption of scarce farmland, and the large amounts of construction material required are factors that stop farmers from installing or maintaining terraces [15].

Waterways

Waterways such as cut-off drainage are permanent structures that aim to collect and guide excess runoff to suitable disposal points. They are constructed along the slope, often covered with grass to prevent destruction, and primarily installed in areas with high rainfall rates [38]. Literature on investigations into drainage systems is rare in Nigeria. The implementation probably needs special knowledge of the water regime of the area and the construction of waterways [39].

These structuresdivert runoff safely from hillslopes to valley bottoms where it joins a stream or river. It may be natural or artificially made and well stabilized with grass, stone, masonry, or concrete. Reinforced concrete waterways are more efficient but have not been widely adopted by smallholder farmers due to their high cost. Creeping grasses such as signal grass *(Brachiariahumidicola*) and bahia grass (*Paspalumnotatum)*are suitable for lining waterways as they cover the ground closely and require little maintenance.Generally, grass species that are weedy and those that can block the waterways and divert runoff should be avoided.

Terraces

Terracing by excavating ditches, construction of earth and some stone bunds, and vegetative barriers are normally defined as SWC structures and are primarily promoted to reduce soil erosion. On sloping lands, terracing is necessary for reducing overland flow rates, thereby contributing to water and nutrient conservation. Although terracing steep lands especially in the Eastern African region has been an indigenous technology among some communities, new methods have been evolving over the years as the need to be innovative with ever-decreasing space for cultivation grows with the population, especially in the densely populated and erosion-prone highlands.

Therefore simply put, terraces are earth embankments built across a slope to intercept runoffwater, reduce soil erosion, and increase in situ water infiltration. Level terraces can reduce runoff by 92% and soil loss by 87–95%, while graded terraces can reduce runoff by 77–92% and soil loss by 98%. Terraces can be designed to channel excess water into waterways or stable outlet. Terraces are stabilized with the non-weedy grass species. In humid and sub-humid areas, farmers prefer fodder grasses for stabilization [1].

Diversion Ditches

Diversion ditches are surface drainage structures constructed across the field to intercept and divert surface runoff from the slope above and drain it to a safe outlet. They are used to protect cultivated lands, collect water for ponds or other storage schemes, and control development of gully heads. They are referred to as cutoff drains when constructed at the boundary between cropland andthe adjacent non-arable land. Channel may either be grass lined or earth lined. Grass-lined channel is more stable and is suitable for broad shallow channels, while narrow and deep channels are often earth lined. Short ditches (250 m long) are suitable in areas with highly erodible soils. On stable soils like red clay loams, the length of the channel should not be more than 500 m [1].

Loose Boulder/Stone/Masonry Check Dams

Check dams are effective for preventing runoff rate and severe erosion in steep and broad gullies, and most suitable for high elevation areas of the catchment. These structures are cheap, having a long life, and fewer maintenance requirements. The depth of gully bed is kept about o.3 m and flat stones of 20–30 cm size are used for the construction of dams. A spillway is provided in the middle of the dam to allow the safe discharge of runoff water [21, 42]. Similarly, gabion check dams are also used for drainage line treatment in sharp slanted gullied areas to check sedimentation, erosion, and to conserve soil moisture.

Modern Technologies of Soil Conservation in Nigeria

Studies on simulation models, remote sensing, and geographic information systems (GIS) are modern technologies that focus on better land use planning and proper soil management, and improve the knowledge on soil conservation in Nigeria. For example, [43]used the Soil Loss Estimation Model for Southern Africa (SLEMSA) to quantify erosion and produced a soil erosion hazard map of Anambra/Enugu states based on the results. He also estimated the erodibility of soils in Southeast Nigeria [44, 45], defined different categories of areas with potential erosion hazards, and developed suitable land use options including arable farming, agroforestry and intensive afforestation.

The Sediment Off-loading Model (SOM), Tectonic Origin Model (TOM), and Soil Erosion Model (SEM) were tested by [46] to improve the understanding and application of these models to find solutions to problems posed by widespread soil and gully erosion. [47] conducted an economic analysis of erosion to suggest appropriate measures for land management.The interpretation of remote sensing data, such as aerial photographs and satellite images, is another useful tool that has been used to compile an inventory of land use and soil degradation and to monitor changes of land use and erosion within time at different scales. For example, [48] combined the analyses of aerial photograph with participatory rural appraisal and logistic modelling to elicit spatial determinants and to model agricultural land use.

The results could be incorporated into a land use framework for planning purposes, scenario analysis or impact assessment at the local government level according to the authors. [10] produced a map on the distribution of gullies in the area of Zaria, northern Nigeria, by interpreting aerial pictures. Studies based on the satellite images LANDSAT TM and NIGERIASAT-1 were made by [49]. He compared the images made in 1986 and 2003 and detected erosion of the Lagos coast line. [50] also worked on the interpretation of NIGERIASAT-1 and recorded its feasibility for mapping and monitoring gully erosion in southeastern Nigeria.The studies show that the modern technologies all improve the understanding of land use, soil degradation, and its consequences and may provide solutions to the problems. Widespread implementation in governmental institutions is still a problem as the equipment and trained staff are often lacking [51].

5. Water Conservation Measures and Issues in Nigeria

Water conservation is concerned with all the strategies, policies and activities aimed at maintaining the natural resource of fresh water. These are all the actions conducted to protect the hydrosphere, and to meet human demand for water. It includes programs of improving water use efficiency, environmental protection and improving the efficiency of industry, housing, utilities, and agriculture. Water consumption methods include any reduction of water losses, water use or pollution as well as the preservation of the quality of water resources; the reduction of water usage by introducing water conservation measures or increasing water use efficiency; implementing of water management systems that reduce or favour the reduction of excess water consumption.

The first big program related to water resources management appeared in the country in 1976, it was the Nigeria River Basin Development Authorities (RBDAs) [52]. Today, water conservation efforts in the country seem to be quite struggling. Such conservation programs as WaterAid, UNICEF, USAID operate in Nigeria, but in most cases they have to work with water sanitation issues.

Some researchers believe that the efforts to protect water resources and treat them with care should be, first of all, related to farmers since 705 of the World's water is used for agriculture. The world over, agriculture consumes more than two-thirds of the water withdrawn from the earth's rivers, lakes and aquifers but, in low-income countries like Nigeria, agricultural water use is some 90 % of the whole. Agriculture is not only the world's largest water user in terms of volume, it is also a relatively low-value, low-efficient and highly subsidized water user. In contrast, poor families in some large cities are forced to spend up to 20% of their income on water [53]. If there is to be enough water for all, on a sustainable basis and if depleted groundwater resources are to be restored, it follows that agriculture, the prime consumer, must take prime responsibility for more efficient use [3].

The line between SWC and rainwater harvesting(RWH) technologies for crop production is very thin. SWC can be described as activities that reduce water losses by runoff and evaporation while maximizing in soil moisture storage forcrop production, but the same could be said of RWH. The two are differentiated by the fact thatunder soil and water conservation, rainwater is conserved in situ wherever it falls,whereas under water harvesting, a deliberateeffort is made to transfer runoff water froma"catchment"to the desired area or storage structure. The important thing is that both systemscomplement each other, and under rainfed agriculture in dry areas, both are necessary nearlyall the time.

A lot of rainwater is lost as it falls andruns off especially in the arid and semiarid landswithout any attempt to collect it. This water canbe harvested and stored for later use when it isneeded. Simple runoff water harvesting systemscan be established from water pan, a pond400–1000 m3dug in the ground to collect runofffromfields. A rock catchment is another waterharvesting technique which has hardly beenexplored in sub-Saharan Africa. These catchments can be constructed wherever there arelarge rock outcrops that catch the rainwater enabling it to freely flow [1].

Water harvesting also involves the construction of dams particularly in drought prone regions as well as the collection of water from rooftops and storage in tanks. Various dams designs using different construction materials abound in the country. Use of local materials at chosen dam sites effectively saves cost whilst achieving the desired result. A rock-fill dam designed by [54] was expected to cost only one-fifth of its estimated cost owing to nearness to locally available construction materials.

Traditions of water harvesting and irrigation are to be found in many parts of Africa that are centuries and even millennia old and evidence survives in landforms, structures and practices; yet sub-Saharan Africa has the lowest proportion of irrigated land in the world. FAO estimates that the proportion of irrigated to total arable land in Asia is 37%, in North Africa 24% and in Latin America 15%, but in sub-Saharan Africa, it is only 4%. Moreover, 75% of all irrigated land in Africa is accounted for by just six countries: Egypt, Madagascar, Morocco, Nigeria, South Africa and Sudan [53].

Nigerian agriculture is basically rainfed, characterized by low production and subjected to the vagaries of weather. Water is therefore a limiting factor to agricultural production in most parts of the country. The physical potential of the nation's irrigation is in the order of 3.14 million hectares, which is about ten times more than the land currently under irrigation [55]. Irrigable area within the River Niger alone constitutes more than 50% of the potential areas. About 855,000ha of this area is under sprinkler irrigation system, while about 90,847ha are under surface system. Nigeria also has large potential for small valley bottom irrigation system development. Over one million hectares of *Fadama* is estimated to be available for irrigation. The irrigation system is constructed to divert water from the valley bottom streams and low flood plains with high water table for agricultural production most especially rice. The technologies needed include water lifting from streams/rivers and shallow tube wells using small pumps .

The seasonality of rainfall in the country results in situations where water is available and often in excess at certain times (especially in the humid tropical rainforest zone), whereas the arid and semi-arid regions are characterized with low rainfall, high evapotranspiration rates and erratic temporal and spatial rainfall distribution.The use of surface flooding in conjunction with groundwater resources has augmented the production of dry season farming considerably.

It is worthy of note that conservation of water is not limited to its quantity alone. Quantity and quality of water are two vectors in water resource management; the former is sometimes used in the context of resources and the later in the context of environment. The quality of water depends on its intended use. The most important characteristics of irrigation water are the total concentration of soluble salts, proportion of sodium to other cations, concentration of potentially toxic elements and bicarbonate concentration as related to the concentration of calcium plus magnesium [56].
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6. Conclusion and Recommendations

Conclusion

The study reviewed the Nigerian Soil and Water Conservation Practices. The study is very essential considering the projection that the world population will be 10 billion in 2050 [57]. Thus, in line with the rapid industrial growth and intensive farming that are expected to occur with its attendant increase of pressure on land and water resources in the near future, it will not be an overstatement to say that judicious use and management of soil and water resources are more vital now than ever. Agriculture has contributed in no small measure to the economic development of most nations, and in Nigeria its potentials can be fully exploited by fully using the services of Soil and Water Conservation Engineers. This can be achieved through the application of soil and water conservation measures or practices capable of reducing runoff, soil erosion and to improve soil quality, water quality, moisture conservation, and overall crop productivity in a sustainable manner.Conservation of soil and water has several agronomic, environmental, and economical benefits.

Recommendations

- Stakeholders in Soil and Water Conservation should engage careful planning for the utilization and management of soil and water resources, with the ultimate goal of empowering farmers with the necessary tools and technical know-how to conserve their soil and water resources.
- Emphasis should be laid on regular research, education and extension (training) of soil and water conservation technologies for stakeholders.
- Soil and water conservation practices should be site-specific considering the variations in soil types, crops, and climatic conditions across the various ecological zones in the country.
- Both surface water bodies and groundwater are under threats in Nigeria. Thus, complete cessation of the practice of discharging wastewater into the hydrological systems (such as rivers and lakes) should be outrightly discouraged. Also, the Protection of groundwater resources should be a priority or the concern of all stakeholders
- There should be development of agricultural strategies that comprises of both rainfed and irrigated agriculture in Nigeria. The federal government of Nigeria should not only concentrate efforts in providing irrigation facilities to the northern Nigeria because during the dry season, water is a limiting factor to crop production in the rainforest zone of Southern Nigeria.
- Government at all levels should be actively involved in providing technical supports and incentives for changing land and water management practices that will result in minimal land degradation and improved water quality.

- Better land use planning and proper soil management using modern technologies like Geographic Information System (GIS) should be advocated to improve soil conservation.

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