Review Article

SOIL EROSION IN NORTHERN NIGERIA: POTENTIAL IMPACT AND POSSIBLE SOLUTION – A REVIEW

Abstract

Aim

The aim of this research is to discuss the environmental soil erosion problem in northern Nigeria: their potential impact and possible solution for sustainable agriculture and livelihood management

Methods

This research was carried out by reviewing literature. The data were derived from; books, journals, internet and conferences reports and Google Scholar and some university library catalogue was used to search the literature. The search terms used are soil erosion, climate change, land degradation, Sahel, drylands, soil conservation, agroforestry, and sustainable land management.

Result

This paper reviewed environmental problems such as soil erosion which are generally considered as the most serious consequences and their impact will remain the main issues for the 21st century. Soil loss will however be prevented or decreased by appropriated crop management such as cover cropping, multiple cropping, and high-density planting. Cover crops has certainly influenced the properties of physical soil which includes infiltration rate, moisture content, and bulk density, increase organic matter content, the levels of Nitrogen (N) by use of Nitrate (N_2) fixing legumes, exchange of cation capacity and crop yields.

Conclusion

The use of cover crops, multiple cropping, agroforestry, and conservation tillage are provided as some of the effective means of controlling soil erosion in the northern part of Nigeria. Therefore, the recommendation here is that the government extension services should incorporate farmers in the affected areas.

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Keywords: Soil erosion; agriculture; degradation; agroforestry

1.0 Introduction

Environmental problems such as soil erosion are generally considered as the most serious consequences and their impact will remain the main issues for the 21st century (Lal, 2003). Because of the negative impact due to the erosion, food security and the livelihood of living population have been affected (Eswaran *et al.,* 2001). The problems have become the main threat to global agricultural sustainability and have caused reduction in the actual and potential soil productivity (Lal, 1991). Nigeria is one of the countries affected by land degradation (FMEN, 2001). It was reported by the Food and Agriculture organisation (FAO, 2005) that soil degradation by erosion is common in Nigeria and it severity was noted to account for 37.5% of 342, 917 km^2 as low, 4.3% of 39,440 km^2 as moderate, 26.3% of 240, 495 km^2 as high and 27.0% of 255, 167 km^2 as very high. Also, in addition, it was estimated that about 50% of Nigerian land surface is being affected by deforestation, erosion drought and salinization leading to desertification, commonly seen in dryland areas of the northern part of the country (FMEN, 2001). The factors that are contributing to the increase of soil degradation leading to erosion in the northern part of Nigeria include population growth, land tenure system, poor agricultural practice, poor vegetation cover and poor environmental government policy (Usman, 2007). Redistribution and management of soil environment as affected by soil erosion are important for high economic food security and soil quality improvement (Usman, 2007). Therefore, the aim of this research is to discuss the environmental soil erosion problem in northern Nigeria: their potential impact and possible solution for sustainable agriculture and livelihood management.

2.0 Methods

2.1 Geography of the study area

Nigeria is one of the largest countries in Africa and has the largest population of 150 million (FMEN, 2001). The country is located approximately between latitude 4^o and 14^o north of the Equator (Salako, 2003) and between longitude 2^o 2' and 14^o 30' east of the Greenwich Meridian, with a surface area of about 91.07 million ha, in which about 57% is believed to be under cropping and pasture management (Cleaver and Schreiber, 1994). Nigeria has the total surface area of approximately 923,770 square kilometres (FMEN,2001) in which 35% are believed to arable land, 15 as pasture, 10% as forest reserve , 10% for settlements and infrastructural development while the remaining 30% is regarded as uncultivated areas

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(FMEN, 2001). The total land area of the dryland in the country is approximately 170,000 km^2 (Anderson, 1988).

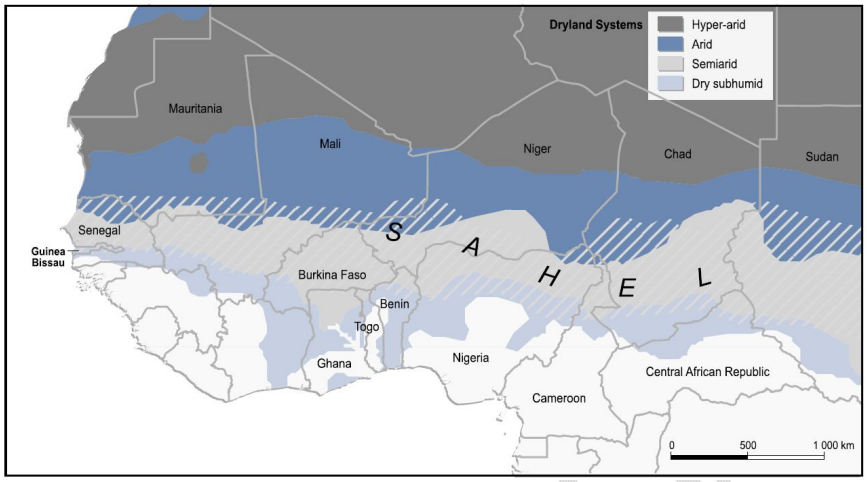

Figure 1: West Africa map shows the Sahel region where the northern Nigerian dryland areas are located. After FMEN (2001)

2.2 Soil Erosion in northern Nigeria

Soil erosion is one of the serious environmental problems in northern Nigeria (Muhamman and Gungula, 2006). Usman (2007) identified two main types of soil erosion in northern Nigeria comprise: accelerated and geological soil erosion. The geological soil erosion occurs under the protective cover of natural vegetation, while the accelerated erosion is the one that exceeds the normal rate and becomes unusually damaging (Brady, 1990; Usman, 2007). Both the geological and accelerated soil erosion have been recognised as the most serious problems that affects the surface soil environment in most of the arid and semi-arid regions of the world (Gomes *et al*., 2003). It was reported that about 351,000 ha of land in northern Nigeria are affected by soil erosion, which comprise about 13 States of the region (FMEN, 2001). The affected states are Adamawa, Bauchi, Borno, Gombe, Jigawa, Kaduna, Kano, Katsina, Kebbi, Niger, Sokoto Yobe and Zamfara. The typical example of this has been given by Usman (2007): (Figure 2).

On the other hand, the high increase of population in northern Nigeria has increased the demand for land, and this has been the result of intensive cultivation with few or no management practices (Weber *et al*., 1996). This condition of intensive cultivation decreases the fertility of soil, destroys soil organic matter, increases soil acidity and speed up soil erosion due to devastating wind speed during the dry period (Stockwell and Fisher, 1996). As

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such, the northern Nigerian farmers are forced to exploit their productivity of their farmland, by increased apply of synthetic chemical such as fertilizers, pesticides and herbicides (Usman, 2007). These types of farmer's agricultural practices are unsustainable in nature and may expose the soil to hazardous conditions such as salinization due to erosion by water (Su *et al*., 2002; Gomes *et al*., 2003). Also, human activities such as deforestation, poor farming system and over exploitation of the forest trees might have speed up the soil erosion process in the region (e.g. Risse, 2001).

Figure 2: Soil erosion in northern Nigeria. After Usman, (2007).

2.3 Potential Impact of soil erosion in Northern Nigeria

As stated earlier that soil erosion is one of the environmental problems affecting farm lands in northern Nigeria. The Federal Ministry of Environment Nigerian (FMEN, 2001) reported that, Nigeria is losing about 500 km^2 of cropland annually due to the soil erosion and the problem is more severe in the dryland areas due to lack of vegetation and proper land use practice (Tribune, 2007). This has led to loss of about 350, 000 ha of arable land yearly in the region, and it leads high increase in food price and poverty rate (Tribune, 2007). However, the Federal Government of Nigeria (FGN, 2005) report that, the impact of soil erosion and other related problem has affected a numbers of population in many States (Table 1).

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Table 1: percentages of the harmful effects of soil degradation in northern Nigeria for the period of 2003 and 2005: (FGN, 2005)

State	Percentages of 2003	Percentages of 2005
Katsina	7	18
Bauchi	3	10
Jigawa	0	11
Adamawa	2	8
Yobe	0	23

[1]The summary of the potential effects of soil degradation in some northern state of Nigeria, in which surveyed indicated the percentage of people that cannot afford food for a month due high increase of price.

2.3.1 Impact and causes of nutrient loses from the soil

There are two main causes of nutrient losses in northern Nigeria which comprise of soil erosion by both wind and water, and land degradation due to desertification, leaching, deterioration of soil structure and loss of organic matter (FMEN, 2001). A research carried out by Mohamman and Gugula (2000) in Adamawa state of northern Nigeria, indicated that soil erosion by wind and water are not only removes the topsoil but hinders the emergence of crop growth and yield due to the loss of nutrient. However, Usman (2007) reported that water erosion erode the top surface soil and might alter its texture and structural mineral quality. It is therefore, important to note that areas affected by soil erosion in northern Nigeria are likely to have low nutrient content than areas that are not affected by the erosion as similarly reported by Mango (1993) in Siaya Distric of Kenya.

2.3.2 Impact and causes of soil degradation on crop yield

Losses of soil nutrient such as Nitrogen (N), Potassium(K), phosphorus (P) and calcium (Ca) in the soil results to decrease in soil quantity and crop yield in some part of northern Nigeria (Agregheore, 2005). Generally, this loss of soil nutrients has become the main causes of food crises in most African countries and the global crop production (Hartemink, 2003). According to Lal (1991) poor crop development due loss of nutrient under the affected erosion areas is more severe in African region, for example, the annual decrease of crop production in 1989 was accelerated by erosion. It was estimated that about 8.2 million ha of cereal crops, 9.2 million ha of roots and tubers, and 0.6 million ha for pules have been decreased (Lal, 1995). However, some studies indicated that about 104 million ha out of 644 million ha are affected by soil erosion (Hartemink, 2003). Therefore, in northern Nigeria

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crops are likely to suffer more under erosion affected areas leading to low yield production as similarly documented by Usman (2007).

3.0 General Discussion

3.1 Possible solutions for controlling soil erosion in Nigeria

World Resources Institutes (WRI, 2000) highlighted two main possible ways to controlling soil erosion: (a) by understanding the environment itself and then to know how it works and (b) by valuing both the human and natural resources in hoping to achieve sustainable development. Some of the examples of these possible ways are discussed below.

3.1.1 Crop management

Cover crops play a vital role in soil conservation (e.g. Figure 3; Lal *et al.*, 1979). Soil loss will however be prevented or decreased by appropriated crop management such as cover cropping, multiple cropping and high density planting (Junge *et al*., 2008). Cover crops which include legumes P. *Phaseoloids*, M. *Pruriens*, and *paspalum notatum* are plants that usually use to grow very fast and close (Lal, 1995), and their dense canopy can prevent rain drops from shedding the soil particles and this will keeps soil loss to supportable edges (Usman, 2007). Cover crops has certainly influenced the properties of physical soil which includes infiltration rate, moisture content, and bulk density (Hulugalle *et al.*, 1986), such properties increase organic matter content, the levels of Nitrogen (N) by use of Nitrate (N_2) fixing legumes, exchange of cation capacity and crop yields (Ibewiro *et al*., 2003).

Figure 3: mulch in practice in Nigeria. After Junge *et al*. (2008).

3.1.2 Multiple Cropping

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Multiple cropping is a farming system which involves different kinds of crops in the farmland (Morgan, 1995). It has been practiced traditionally by Nigerian farmers, and even now is common in some part of the country (Olukosi *et al.,* 1991). Studies about the mixed cropping system has been intensified since the late 1960s (Norman, 1974), and since that period several studies have been carried out on improving mixed cropping system (Junge *et al.,* 2008). Typical example of this is shown in Figure 3.

3.1.3 Agroforestry

A number of studies have been carried out by groups of researchers in which they indicate the effectiveness of the Agroforestry system in controls and prevents soil against erosion (Usman, 2007; Junge *et al.,* 2008). For instance a research that was carried out by Lal (1989), indicates that the decrease of soil erosion by alley cropping apparently depends on the layout between the hedges and species, and the result also indicated that 4-m spaces was suitable for soil erosion control with *L. leucocephala* and 2-m spaces for *G. sepium*. The perennials stage is important as numerous species become very effective sediment traps for about 2 to 3 years after planting (Lal, 1990). Also intensive rooting by woody perennials will however increase the structure and infiltration rate of soil, the quantity of runoff and therefore soil loss are decreased by alley cropping (Kang *et al*., 1995). Typical example of this is shown in Figure 4.

Figure 4: Alley cropping system in Nigeria. After Junge *et al.* (2008).

3.1.4 Conservation Tillage

Conservation tillage refers to a method of seedbed preparation which comprises presence of residue mulch and an increase in surface roughness as the main criteria (Lal, 1990).

Minimum Tillage is a soil conservation practice in which soil preparation is decreased to the minimum essential for crop production and where about 15% to 25% of residues on the surface of the soil (Morgan, 1995). Also, no-till or zero tillage is characterised by the removal of all mechanical seed bed preparation with the exception of a hole in the ground for seed location or opening of a narrow strip (Usman, 2007). In addition, ridge tillage is the practice of sowing or planting of crops in rows on the top, along the both sides or in the channels between the edges which are already prepared at the commencement of each cropping period (Junge *et al.*, 2009). Tied ridging comprise of extra cross-ties in the furrows between nearest contour ridges (Lal, 1991). Lal (1984), carried out a research on quantifying the effects of different practices of tillage on runoff and erosion, in which the results show that soil loss was about 42 times higher from the ploughed watershed (5.5 t ha-1) than the no tillage watershed (0.1 t ha-1). This result indicated that conservation tillage is very effective for the control of soil erosion through the protective effect of residue mulch as noted by Usman (2007).

4.1 Conclusion and recommendation

Soil erosion has been viewed as one of the environmental soil problems in northern Nigeria. It affects both the land and human population and has potentially affected crop development. The use of cover crops, multiple cropping, agroforestry and conservation tillage are provided as some of the effective means of controlling soil erosion in the northern part of Nigeria. Therefore, the recommendation here is that the government extension services should cooperate with farmers in the affected areas to adapt a more sustainable measure of converting soil erosion through the use of cover crop, multiple cropping, conservation tillage and agroforestry.

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