An Overview of Soil Fertility Degradation in Mubi Area, North-Eastern Part of Nigeria.

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Abstract- In Mubi area, farming activities by the peasant farmers are becoming less productive compared with the past, due to degradation of the inherent fertility status of the soils. This might be attributed to so many human induced, agronomic and climatic factors coupled with less effective or poor soil conservation techniques by the farmers. Therefore, this study aims at highlighting soil fertility degradation in Mubi area, North-eastern part of Nigeria. It was revealed from this study that soil erosion, overgrazing, deforestation, crop removal, indiscriminate bush burning were the common substantive factors responsible for soil degradation in the area. Temperature variation and rainfall intensity were the common substantives factors responsible for soil fertility degradation in the area. Similarly, majority of the farmers in the study area have not adopted soil conservation techniques on their farmland. It is therefore recommended that, government should formulate policies, laws and legitimate sanctions on human activities causing soil fertility degradation as well as other environmental degradation in the area before the situation get out of hand. Similarly, farmers in the study area should be equipped with technical skills on soil conservation techniques by the extension agents and provided with available farm implements and equipment to enable them to restore and sustain the inherent soil fertility status in order to realize maximum food production for the growing population in the study area and the region at large.

Index Terms- Soil fertility, Soil Conservation, Degradation, Techniques

I. Introduction

The United Nations and a number of global and regional institutions/entities have throughout the years recognized that growing soil degradation is not only a major threat to humanity, in that it compromises the continued tenure of food availability for a growing global population, but also since it mitigates against ongoing efforts to avert further species and ecosystem losses in all geographic regions (particularly in sensitive latitudes), reversal of landscape deterioration and to prevent negative implications resulting from climate change.(United Nations and Globalization on Soil Degradation Threats, 2018).Soil fertility is measured by its capacity to support the population of plants and animals above ground and flora and fauna below ground (Gopal 2002). Similarly, Stepherd (2002) defined *Soil fertility* as a measure of soil's ability to sustain a satisfactory crop growth on both short and long terms. Soil fertility is determined from sets of interactions among soil physical, chemical and biological activities. However, soil fertility is not a stable property, but is rather a dynamic one. Fertility status of a soil is a natural inherent gift bestowed within the layers of soil which are governed and regulated under various Physico-chemical, Geo-microbial and Hydro-climatic processes eventually subjecting the soil in to stage of depletion from its inherent nature. Generally, there are various factors influencing soil nutrient losses. Roy *et al*, (2007), stated the basic factors causing soil nutrient losses which are: soil erosion, crop removal, human activities, leaching and losses in gaseous forms. In addition, Gopal (2002) reported that, one of the major problems affecting food production in Africa is the rapid depletion of nutrients in smallholder farms. Also, Badiane and Delgado (1995) mentioned that the smallholder farmers are poorly resourced and unable to invest heavily in soil fertility inputs, particularly in purchasing mineral fertilizers. The major pathways of soil fertility decline on farmlands include the loss of nutrients through erosion, leaching, volatilization, crop uptake and harvests without proportionate replenishments. Thus, Food security for an existing population is largely a problem of good soil management on existing cultivated lands and requires increased number of trained manpower (in conservation techniques) besides the capital intensive fertilization.(Yaalon and Arnold, 2000). Recently, it was observed Akintola, Odu and Baiyegunhi (2013) that intensive cultivation and cropping, coupled with less or no adoption of conservation techniques concerned the farmlands' nutrient status. Technically, it is a known fact that soil fertility degradation is an inevitable phenomenon not a disaster, but it might eventually turn in to disastrous scenario if no proper and timely conservation techniques adopted or employed with the aim of ameliorating the existing nutrients predicaments. Therefore, soil conservation techniques become inevitable practice for restoring soil nutrient. However, not all farmers are equipped with the skills, knowledge and adoption of such techniques effectively due to some reasons. Among such reasons include that of Fapojuwo, *et al.*, (2012) who argued that, the earlier mechanized agricultural practices introduced by most regional governments in the early 80s affected the various known traditional soil conservation methods. Simlarly Ajayi, *et al.*, (2003) found out that farmers change from conserved farming techniques to mechanized farming as result of government consistent practices of mechanized agriculture without giving thought on aspects of soil conservation.

In Mubi area soil fertility is low and continuously undergoing severe degradation with a low a soil conservation

practices (Ray, 2006 and Sadiq and Tekwa, 2018). These effects of such a decline in nutrient supply significantly reduce crop yields in the study area. Proper understanding of the factors militating against soil fertility degradation is highly essential in current situation. Therefore, this study undertaken to highight soil fertility degradation in Mubi area, with the specific objectives of identifying major factors depleting the soil fertility and providing conservation practices employed by the farmers towards restoring and sustaining the inherent fertility of the soil as well as suggesting possible workable solutions to the menace in the area.

II. THE STUDY AREA

Mubi land area lies between latitudes 9º30' and 11º north of the equator and longitudes 13º 00' and 13º45' east of the Greenwich Meridian at an altitude of 696 m above sea level. It is situated in the northern guinea savannah ecological zone of Nigeria. It has a land area of 4,728.77 km^2 and a population of 759,045 people in 2003 (Adebayo, 2004). The climate of the study area is characterized by alternating dry (November to March) and wet (April to October) seasons. The mean annual rainfall ranges from 700 mm to 1,050 mm. The seasonal maximum temperature of 37.0ºC occurs in April and minimum of 12.7ºC in January. Maximum relative humidity is 90% and minimum is 50% (Adebayo, 2004).The vegetation is of typical which implies grassland interposed by shrubs and few trees mostly acacia (*Acacia albida*), locust-beans (*Parkia biglobosa*) and Eucalyptus trees (*Eucalyptus spp*) among others (Adebayo, 2004, Tekwa and Usman, 2006).

III. THE SOIL CLASS OF MUBI AREA.

Studies have revealed that the soils of Mubi area fall under the category of lithosols Adebayo, 2004; Tekwa and Usman, 2006). Lithosols constitutes one of the upper categories of the Food and Agricultural Organization (FAO) and United Nations Economic, Scientific, and Cultural Organization (UNESCO) soil classification system. They refer to soils with rock-basements within shallow depths from the soil surface as shallowness and stoniness of the surface soil depths, and are usually characterized by orchard-type vegetation due to limitations in inherent fertility (Nwaka *et al*., 1999). Mubi soils have also been classified as Alfisols based on the United States Department of Agriculture (USDA) classification system and the soils are generally of low fertility status to support heavy nutrient requiring plants (Tekwa, *et al*., 2011).

IV. REASEARCH METHODOLOGY

To achieve the specific objectives of the study, the author comprehensively studied the limited available pertinent past and previous studies conducted in the area which form the basis of the secondary data for the research. In addition, on farm observations, in-depth interview sessions, and focus-group discussions were undertaken for the background and qualitative data respectively

V. SOIL FERTILITY DEGRADATION IN MUBI AREA.

Mubi soils are located around Savannah region of the tropical West Africa. Thus, savannah soils are generally low in inherent fertility. Lithosols are generally characterized by low nitrogen (N), phosphorus (P), cation exchange capacity (CEC), total exchangeable basis (TEB) and low activity clays (Landon, 1991). Globally, Lithosols largely occur within the fertile and problem soil distribution zones and are mostly found in tropical than in the temperate zones (Badejo *et al.,* 1999). These soils are susceptible to crusting and compaction, surface erosion and leaching of plant nutrients just as glared in soils of the study area. These soil characteristics makes soil fertility management a major task in crop production practices around Mubi area. Thus, the soil status of the area are seriously experiencing exacerbated depletion of its fertility which is a prerequisite to optimum food production as a result of the following overviewed glaring inflicting factors. These factors are grouped into three; namely ***agronomic anthropogenic*** **and climatic factors**

1. AGRONOMIC FACTORS.

- **Soil Erosion**

Soil erosion by water or wind agents selectively damages the soil by removing organic matter, soil particles, plant nutrients, pedon thickness, and reducing soil chemical capacity to retain added nutrients. Hence, erosion removes soil particles that are necessary for water storage and denies root exploration for plant nutrients. (Sadiq and Tekwa, 2018). In West Africa, soil erosion gulps about 10-21 tons of top soils per ha on nearly gentle slopes of 0.4 - 0.8% and up to 30 - 35 tons on 1-2% slopes (Serageldin, 1987). In Nigeria, it has been reported that over 25 million tons of valuable top soils are lost annually to erosion (Ezedinma, 1982). Similarly, soil erosion in Mubi region is being aggravated by factors such as topography, rainfall intensity and soil types. Above all unrestricted human activities such as overgrazing, continuous cultivation, deforestation have aided the acceleration of soil erosion in Mubi region. (Musa and Adebayo, 2004).

In Mubi area, an estimated average weight of soil loss from some sampled gully erosion features ranged from 159,574.14 kg at Vimtim with narrow gully and 725, 345.01 kg at Muvur with a wider gully in 2003, and it ranged from 101,556.0 kg at Gella to 98,400.86 kg at Muvur in 2004 (Tekwa and Usman, 2006). In 2003, about 884.91 tons of soil was lost at Vimtim and Muvur, while 199.95 tons were lost at Gella and Muvur, totaling 1084.87516 tons of top soils lost annually, and thereby minimizing the cultivable land size in the areas. The magnitude of soil loss caused by gully erosion was greater at Digil, followed by Muvur, than Madanya and Lamorde. However, the soil losses were lesser at Vimtim and Gella sites (Tekwa and Usman, 2006). Despite the larger soil loss by the gully erosion at Digil, Yet, no farmer used any cultural methods to control the observed erosion in the area. Thus, gully erosion is rampant in Digil area in Mubi North and Lamurde area in Mubi South respectively. (Musa and Adebayo, 2004). The glaring devastation of soil erosion on soil was proved from the pictures depicted on the plates below.

Sabon-Gari Vemtim Dedif Wuro-Harde

Plates1. Effects of soil erosion on farm degradation around Mubi area.

- **Crop Removal**

The amount of soil nutrient removals by crop plants for their growth and development may not be commensurable with external nutrient inputs. Experiences from some depleted soils of Africa shows that 33% of the total soil N can be lost within 10 years and 33% of P within 20 years, thereby causing a loss in grain yields by twice higher per ha. In Africa, several countries have a negative nutrient balance of more than 60 kg of its total required nutrients annually (FAO, 2000). The unequaled nutrient balances occur, where nutrient removal exceeds nutrient additions (Roy *et al.*, 2007). This may cause soil fertility depletion or nutrient mining in excess amounts.

In Mubi area, increased continuous cropping for more decades with less or no nutrient addition h**as** resulted to negative nutrient balance.(Sadiq and Tekwa, 2018) A negative balance may be acceptable for a short period, but where prolonged, it may lead to soil deterioration and is usually very expensive to reclaim depleted soils (Roy, *et al.*, 2007). Generally, imbalances in soil fertilization are a major threat to sustainable crop production in on depleted farmlands.

- **Continuous Cropping Practices**

The report of Sadiq and Tekwa, (2018) revealed that, the unavailability of fertile agricultural lands has made most farmers engaged in continuous cropping systems and without involving proper management techniques in the study area. Some farmers in Mubi area can cultivate a piece of land for over 15 years without minding the recommended soil nutrient management rules. This farmer behavior has altered the inherent fertility status of Mubi soils and thereby causing lower crop yields over time as a result of diminishing land returns. Thus, Gadiga, (2004) stated that, most of the problems, of course, are derived from the fact that large proportion of crop production in the region is in the hands of peasant farmers operating within the frame work of traditional system of agriculture.

2. ANTHROPOGENIC FACTORS.

According to Mayo (2007), an environment is made up of its immediate surroundings and consists of the earth and the atmosphere occupied or used by man. Man creates or damages the environment through his actions. For instance, in Mubi, if human actions are not controlled or monitored, it may lead to adverse effects on soil fertility and long term crop productivity. Some of the evident anthropogenic induce activities that influence nutrient losses in the study area include:

- Deforestation,
- Overgrazing,
- Indiscriminate and excessive bush burning,
- Removal of crop residues.

- **Deforestation**

Deforestation can be seen as an act of indiscriminate felling of trees or shrubs for timber and other agricultural purposes. Greenfield (1989) reported that in 1983, desertification was assessed to affect 90% of Africa's range lands, 80% of rain fed croplands and 30% of irrigated lands, which is indeed awful. Deforestation may lead to soil erosion, loss of soil nutrients, and decrease in transpiration and evaporation losses, which may consequently lead to desert encroachment. Historically, trees are cut down for timber, firewood and for other domestic or agricultural purposes around Mubi area. (Sadiq and Tekwa, 2018) Consequently, these actions may lead to climate change and global warming problems as well as depletion of certain soil resources. Deforestation activities in the study area over the years are now triggering desert encroachment and extensive erosion. Similarly, Adebayo (2004) explained that vegetation in Mubi-north has been seriously depleted and the limited woodlands (of about 25 %) have been reduced by half. These woodlands are fast losing their existence through deforestation. Farmlands themselves are gradually transforming into bare surfaces due to a combination of over- cultivation and urbanization. The fact that Mubi area has the largest land covered by bare surfaces, in the region makes it a disaster zone in the whole region. The evidence of deforestation in the study is very clear from plates shown below;

Plate 2. Deforestation activity at Sebore Village in Mubi area .

- **Overgrazing**

Overgrazing implies excessive grazing or removal of grasses by animals, thereby exposing soils to degradation. Production sytem of livestock is predominantly extensive rather than intensive, using range-land, crop residues and collected fodder to a greater extent than sown pastures and concentrates (Gadiga, 2004) Therefore, looking at the extensive nature of the production system, nomadic cattle rearers move their herds in and out of the area in accordance with seasonal changes as a consequence predisposing the soil to loss of organic matter, of texture, structure and compaction which are premises of nutrients availability. Similarly, Mubi is one of the major international cattle markets in Africa. High population of cattle reaches Mubi through several

routes of Cameroon and Chad Republics and thereby causing overgrazing and soil compaction problems that initiate soil degradation. Overgrazing affect soil structure, compaction rates, porosity, and top soil depletion. This may lead to soil erosion and reduced soil fertility. The plates below portrayed the evident overgrazing in the area.

Digil Sabon- Gari Sebore

Plates 3.Effect of overgrazing on destruction of crop residues and soil structure

- **Removal of Crop Residues**

Crop residues include harvested and un-harvested plant parts such as cereal-straw, stubbles, legume-haulms, plant roots, cereal-husks cassava peels, cocoa pods, etc, are all components of crop residues. Usually, the amount of crop residues after each harvest are extensively and immediately utilized for many purposes such as fencing, housing, fodder (hay), and fueling (fire wood) at the expense of soil surface coverage. In Mubi region, most farmers usually gather crop residues on their farms and sell them to pastoralists as a source of income without minding its negative implications or even understand the need to recycle such crop residues as sources of soil fertility enrichment on their farmlands. Understanding the pivotal role of crop residues in soil improvement by the peasant farmers in Mubi is indeed crucial. Himadri and Dharamuir (2009) reported that cereal-straw and residues on maturity contains about 0.5% nitrogen (N), 0.6% P_20_5 and 1.5% K_20 on the average, while the quantity of nutrients in legume residues are much higher than those in cereal straws. The nutrient potentials of cereal straw/residues are: 0.7 million tone of N, 0.84 million tone of P_2O_5 and 2.1 million tons of K_2O. It was observed that even if 50% of these crop residues are utilized as animal feeds, the rest will still be mobilized during recycling of plant nutrients and in some other beneficial activities in soils and plants with optimal improvements. In Mubi region, more than 50% of crop residues are utilized for animal feeds and othaer economic purposes (Plate: 4.).

Plate: 4. Removal of crops by the farmers for economic purposes from various places within Mubi Region.

- **Indiscriminate Bush Burning**

This is a continuous uncontrolled burning of bush which subsequently destroys soil structures, texture, microorganisms and losses of nutrients in gaseous form. Over the years, most of the indiscriminate bush burning around Mubi area occurs during hunting of rodents and other bush meats by some of the villagers at the end of the rainy seasons. Bush burning activities extensively affects soil structures and microbial population. In addition, pastoralists also set fire on bushes usually at the onset of rainy seasons in order to facilitate faster germination, sprouting or rejuvenation of some grasses and shrubs as feeds for their livestock. (Sadiq and Tekwa, 2018).

Plate.5: Indiscriminate bush burning practices Mubi area.

Generally, from the historical point of view, human induced soil degradation had affected 46 million ha in Africa and 15 million ha in Asia (FAO, 2000) out of these, 25 percent of soils in Africa and 67 percent in Asia are moderately to severely degraded (Roy *et al.*, 2004).

3. CLIMATIC FACTOR

Climate change is an overarching driver affecting numerous soil nutrients availability in the area most especially organic matter. Organic material in the soil is essentially derived from residual plant and animal material, synthesized by microbes and decomposed under the influence of temperature, moisture and ambient soil conditions. Ajoade,2004), most plants begin to accumulate organic matter at the temperature of about 0°C increasing in amount up to 25°C then decreasing to zero at 40°C. The temperature regime in Mubi region is warm to hot throughout the year, because of high radiation which is relatively evenly distributed throughout the year had leads to loss of organic matter because of higher decomposition rates most especially when there is a gradual increase in temperature from January to April with seasonal maximum occurring with about 35-37 ^{0}C respectively. Similarly, rainfall intensity, which relates the total amount of rainfall to its duration, is very important parameter controlling the probability and seriousness of soil erosion. Mubi region has the highest mean rainfall intensity (18-24 mm) in Adamawa state (Adebayo, 1997: Musa and Adebayo, 2004). This high rainfall intensity makes the area more vulnerable to soil erosion as a result of high runoff, infiltration and leaching of soil nutrient subsequently reducing fertility of the soil area respectively.

VI. CONCLUSION

Obviously, the impact of soil fertility degradation in Mubi area is highly glaring and easily observable and felt by the farmers. This phenomenon in its practical sense affects hugely the quantity of food crops produce in the area. Most of the factors responsible for the decline in soil fertility in the area are of human induce agronomic and climatic factors which encompasses crop removal, poor management, soil erosion, deforestation, overgrazing, bush burning among others. Similarly, despite the apparent fertility degradation of soil in the study area the efforts made by the peasant farmers in the area towards application of cultural soil conservation techniques were very low and also some were found to be non-existent. Farmer's attitudes on lack of technical know-how and shortages of man power are hindering effective adoption of soil conservation techniques in the area.

VII. RECOMMENDATION

The dream of optimum food production for the growing population will be actualized when the aforementioned soil fertility dilemmas facing the farmers in the study area are dismantled. To dismantle them, this paper therefore recommends the ardent need for inculcating extensions agent actively towards educating the farmers on the substantive factors affecting soil fertility degradation. Intensive training on workable soil conservation techniques that will improve and sustain the nutrient status of the soil should be made available to the small scale farmers in the area by the extension workers.

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