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The Role of Organic Matter in Tropical Soil Productivity

M. S. Adiaha

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The Role of Organic Matter in Tropical Soil Productivity



M. S. Adiaha

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FOREWORD

Soil infertility has been one of the factors fueling global food shortages, especially in the humid tropics. As part of the effort to combat this problem, then the need for this work arises. The book seeks ways soils of the tropics can be fertilized using soil amendment materials like compose manure including the use of human urine as a crop fertilizer for increase soil fertility as one of the remedy to combat global food insecurity.

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PREFACE

The urge to meet human food demand in the face of climate change and rapid increase in human population is a factor necessitating the birth of this work. Soil fertility plays an important role in food crop production, hence, the book addresses essential areas of soil amendment, soil conservation including irrigation and drainage, seeking measures for increasing soil fertility status for maximum/productive cultivation of crops to meet human/animal food needs and as a guide to mitigate the negative impacts of climate change in Agriculture.

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CERTIFICATION

This is to certify that this survey on the role of organic matter in tropical soil productivity was carried out by ADIAHA, MONDAY SUNDAY with approval from the Department of Agronomy (Soil and Crop Science), Faculty of Agriculture and Forestry, Cross River University of Technology (CRUTECH) Obubra Campus, Nigeria.

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Date: 15/10/2015

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DEDICATION

This article is dedicated to **SundayAsuqwu Adiaha** who loves to read and experiment.

ACKNOWLEDGMENT

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DECLARATION

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The Role of Organic Matter in Tropical Soil Productivity

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ABSTRACT

A survey on the role of soil organic matter (SOM) in tropical soil productivity was carried out with the objective of highlighting on the effects and benefits of organic matter on soil biophysical chemical properties and yield of crops in the tropics. It was revealed that tropical soils are inherently low in fertility due to predominance of kaolinitic clays. The soils are low in CEC, OM, available P and base saturation. Inorganic fertilizers are scarce and costly in addition to negative effects on soil causing acidification and induced micronutrients deficiencies. Organic matter contain a wide range of macro and micro nutrients. On mineralization, these nutrients are released, in addition to contributing of organic matter to the soil. This manure also improves physical properties and ultimately increase crop yield on a sustainable basis.

Keywords: Soil fertility, Tropical soils, Human urine, Food security, Organic matter

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CHAPTER ONE

1. INTRODUCTION

1.1. BACKGROUND INFORMATION

Soils are our major natural resources because most of our food and clothing comes directly or indirectly from them. Tropical soils are highly weathered, Kaolinitic and low in cation exchange capacity (White, 1987; Donahue et al, 1990). These soils can easily develop a net positive charge at low pH due to their sesquioxides nature (White, 1987). Inorganic fertilizer which are the basis of modern and large scale agriculture are easily leached from the soil and quickly become unavailable to crops. Sobula and Osiname (1982) stated that Nigerian soils are inherently infertile and noted further that in addition to having lowest yields, Africa has the highest nutrient depletion figures.

Organic fertilizers has been found to be biologically efficient in the maintenance of soil fertility which is critical to sustainability, particularly of tropical fragile soils. Tropical soils are mostly deficient in the content of organic matter.

Soil organic matter, influences several critical soil functions and is affected by land management practices.

Organic matter impacts the physical, chemical, and biological characteristics of the soil. Different organic matter pools affect different soil functions (Baldockand Skjemstad, 1999).

The role of soil organic matter is intrinsically linked to biological functioning: organic matter is the main source of food and energy for soil organisms (Jeffery et al., 2010). The biological functions of SOM are primarily to provide metabolic energy that drives biological processes, to act as a supply of macro-and micronutrients and to ensure that both energy and nutrients are stored and released in a cycle that connect about-and belowground energy transformations.

1.2. OBJECTIVES OF THE STUDY

- 1) To highlight on the effect of organic matter on soil physical properties
- 2) To highlight on the effect of organic matter on soil chemical properties.
- 3) To highlight on the effect of organic matter on soil biological properties and
- 4) To highlight the role of organic matter on soil fertility and crop performance.
- 5) The text seeks to present irrigation and drainage impacts on Agricultural productivity.

1. 3. METHODOLOGY

Field observation and confirmation practical was carried out. Numerous research literatures were; consulted, reviewed, verified and adopted. These were the methods used for data and findings presentation.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1. CONSTRAINTS TO TROPICAL SOIL PRODUCTIVITY

The productivity of tropical soils has been a subject of concern because of its management problems associated with sustainability. It is noted by White et al, (1987); Agboola and Unamma (1991) that tropical soils are highly weathered, kaolinitic and low in cation exchange capacity. Declining soil fertility has been identified as the fundamental cause of declining crop yields in many parts of Africa (Sanchez and Miller; 1986). The intensive weathering and leaching has resulted in a high proportion of kaolinitic clays with low CEC.

Hole et al., (2005) reported that each year about 5-10million hectares of crop land are taken out of production because of soil erosion, nutrients depletion, salinization and water logging. Tropical soils generally have low inherent fertility (Brussard et al. , 1993), low base saturation and low phosphorus availability (Sobula and Osiname, 1982). Obi and Ebo (1995) reported that Nigerian soils are inherently infertile, acidic and low in organic matter content.

There is the large-scale export of nutrients through produce and stubble, which in conventional system is replaced chemical fertilizers. In contrast, ex situ or in situ green manures, animal manure, cover crops or different types of organic matter are used individually or in combination to replenish exported nutrients in organic systems (Stockdale et al., 2000). In the tropics, where soil fertility is generally low (Hartemink, 2003; Zingore et al., 2003), the decline in crop yields, even in conventional-cropping systems due to excess soil mining without much of organic matter returns to maintain soil fertility (Gachengo et al., 1999; Eilitta et al., 2004). Hence the addition of organic matter becomes very important in tropical cropping systems.

FAO (1999) reported that mineralization and depletion of organic matter is very fast and can reach low levels after 5 to 6 years or less, especially in sandy soils. It was reported that excess tillage in the tropics causes erosion that leads to loss of soil structure and the formation of compacted layers at 10 to 15 cm depth, that can result in reduced water infiltration and considerable soil loss. Rainfall erosivity is quite intensive in tropical savannah increasing the breakdown of surface soil aggregates, sealing the soil surface, reducing infiltration and increasing run-off (Dedecek et al., 1999).

2.2. SOURCES OF ORGANIC MATTER IN SOIL

Soil organic matter consists of diverse, heterogenous components. Theng et al., (1989) reported that living C rarely exceeds 4% of total soil organic C and is present as roots, microorganisms and soil fauna. Non-living C represents the major portion of organic C, consisting of surface litter, root litter, microbial metabolites and humic

substances. The living and non-living C component constantly interacts, as do the saprophytic organisms that acquire metabolites from non-living C in the soil and then die.

The term “soil organic matter” (SOM) has been used in different ways to describe the organic constituents of soil. Baldock and Skjemstad (1999) defined SOM as “all organic materials found in soils irrespective of origin or state of decomposition”. SOM consists of C, H, O, N, P and S. Included are living organic matter (plants, microbial biomass and faunal biomass), dissolved organic matter, particulate organic matter, humus and inert or highly carbonized organic matter. Part of soil organic matter consists of carbohydrates, lipids and proteins that are abundant in fresh plant residues. These are rapidly metabolized, immobilized or decomposed (Scharpenseel, 1988).

Organic matter is categorized into aboveground and belowground organic. Aboveground organic matter includes plants and animal residues while the belowground matter comprises of living soil fauna and micro flora, partially decomposed plant and animal.

2.3. CROP RESIDUES

Crop residue is divided into two types- field and process residue. Field residue is materials which are left in an agricultural field or orchard after the crop has been harvested. This include stalks, stems or leaves and seed pod. The residue can be ploughed directly into the ground or burned first.

Process residue: They are materials which are left after the crop is processed into useable resource. It includes husks, seed and root which can be used as soil amendment, fertilizer and in manufacturing. They have high C:N ratio with low N content but fairly high Potassium and silica content which help to improve the resistance of crops to disease and lodging. Fibrous materials provide an energy source for soil microorganisms which improve soil physical properties.

Table 1. Amount of Nutrient in Crop Residues (kg/of dry weight).

Resistance	Nitrogen	phosphorus	Potassium
Rice straw	5	0.9	23.9
Sugarcane leaves	4.9	2.1	5.6
Corn trunk	5.3	1.5	22.1
Soya bean	35.4	10.4	35.4
Grass	4.9	5.8	7.4

Saw dust	3.0	1.2	23.3
Paddy husk	3.6	0.1	10.6
Pineapple leaves	11.2	4.8	26.6
Ash	0.6	19.5	134.8

Source: Land Development Department, Thailand (2006).

2.4. GREEN MANURE AND COVER CROPS

Green manure can be defined as a practice of ploughing or turning into the soil undecomposed green plant tissues for improving physical structure and soil fertility. The green manure crops supplies organic matter as well as nitrogen, particularly if it is a legume crop.

Table 2. Nutrient Content of Important Green Manure (% on dry weight basis).

Crop	Nitrogen	Phosphorus	Potassium
Sesbania aculeate	3.3	0.7	1-3
Crotalaria juncea	2.6	0.6	2.0
Sesbania speciosa	2.7	0.5	2.2
Tephrosia purpurea	2.4	0.3	0.8
Phaseolus tribolus	2.1	0.5	
Azadirachta indica	2.8	0.3	0.4

Source: FAO, Soil Bulletin (1987).

2.5. ANIMAL WASTE

Amending soil with animal waste has been old practice. Animal waste can supply nutrients, OM and enriched soil with beneficial organisms.

Dung's comes mostly as undigested material and the urine from the digested material. More than 50% of the organic matter that is present in dung is the form of complex product consists of lignin and protein which are resistant to further decomposition and therefore the nutrients present in dung are released very slowly (Hsieh and Hsieh, 1990).

Table 3. Amount of Nutrient from Farm Yard Manure (g/kg of dry weight).

Manure	Nitrogen	phosphorus	Potassium
Cow	19.1	0.9	23.9
Chicken	37.7	2.1	5.6
Buffalo	12.3	1.5	22.1
Duck	21.5	10.4	35.4
Pig	28.0	5.8	7.4
Dung	5-6	1.2-2.0	5-6

Source: Earth Planet Foundation, Thailand (2003).

2.6. COMPOST

Compost is any organic material that undergoes decomposition under controlled conditions. Any organic material can be converted to compost, but there are rules regarding what material can and cannot be used. Compared to some uncomposted animals waste, it may have low nutrient levels. Nutrients from compost are often less available to the crop; thus, compost may be more useful for building SOM. Compost causes less water pollution.

Nyamangara et al., (2003) reported that management of soil organic matter by using composted organic waste is the key for sustainable agriculture.

2.7. USE OF HUMAN URINE AS CROP FERTILIZER

Table 4. Crop Yields in Metric Tones Per Hecter influenced by urine fertilizer, and chemical fertilizer with nutrient equivalents of urine fertilizer. (CREPA, 2006).

Type of crop	Non-fertilized	Urine fertilizer	Chemical fertilizer	Country of trial
Cabbage	19.1	32.0	31.0	Togo
Cassava	45.0	60.0	60.0	Iv. Coast
Cotton	0.18	0.35	0.38	Mali
Corn	2.4	3.6	3.5	Benin

Eggplant	2.8	16.0	17.1	Burkina
Lettuce	6.8	15.7	13.3	Togo
Okra	1.7	2.3	2.6	Burkina
Sorghum	2.3	3.8	4.1	Burkina
Tomato	2.1	5.2	5.8	Burkina
Yams	4.0	8.0	6.0	iv. coast

Source: CREPA, 2006

There is a growing awareness of the valuable nutrient being lost in human waste. A new paradigm is forming in the water and wastewater management sector to focus on the resources that can be recovered from wastewater rather than the constituents that must be removed (Guest et al, 2009). Current human waste can be returned to natural system in a way that benefits food production soils.

2.8. THE BENEFITS OF URINE AS A FERTILIZER

Urine works so well as a fertilizer. Human urine contains very few, if any, pathogens but contains the majority of plant fertilizing nutrients (Esrey et al., 2001; Ray, 2010). With the high nutrient-low pathogen combination presents urine as an easy and safe material that can be used to increase the yields of food crops. In addition to the ease and low cost of separating urine for agricultural use.

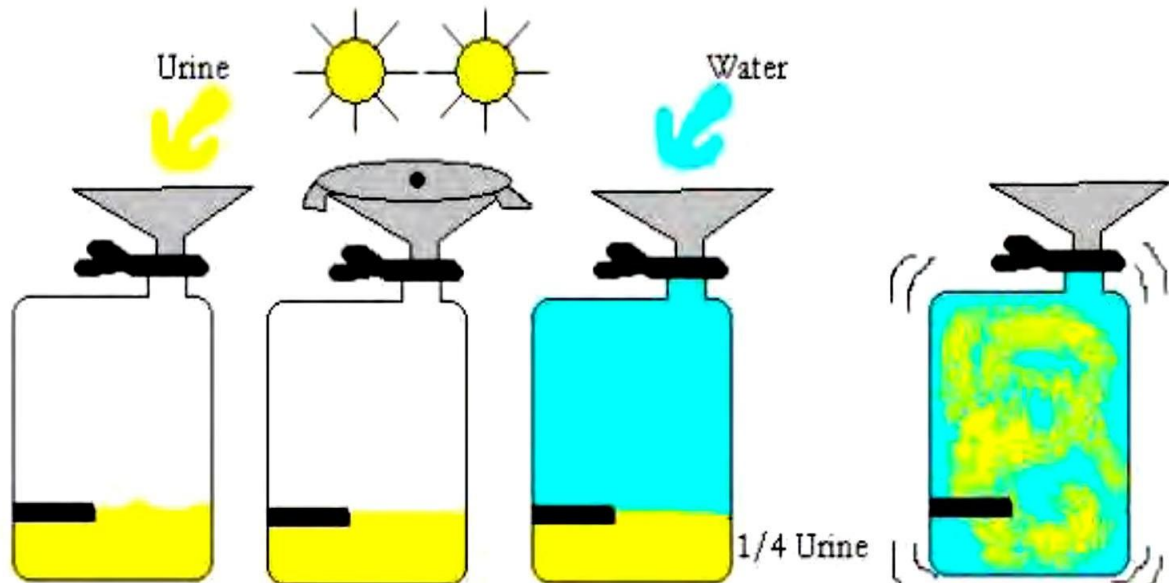


Figure 1. The Process of Collecting Urine and Making Fertilizer. Fill to " with pure urine, letstand for 48 hours, take to the application area, fill to the brim with water, and mix

Source: Ray (2010)



Figure 2. Urine diversion for a compost toilet
(Photo by Karin Ahlgren, used with permission) (Kvarnstrom et al., 2006: 7)
Source: Ray (2010)

Application Rates for Urine fertilizer

“Fields: 2 Liters of urine fertilizer* per Square Meter of field crops per Week.

Gardens: 4 Liters of urine fertilizer* per Square Meter of garden crops per Week.

Trees: 2 Liters of urine fertilizer* per Tree per Week.

**Note: These doses are given in liters of urine fertilizer, NOT pure urine.” (Ray, 2010)*

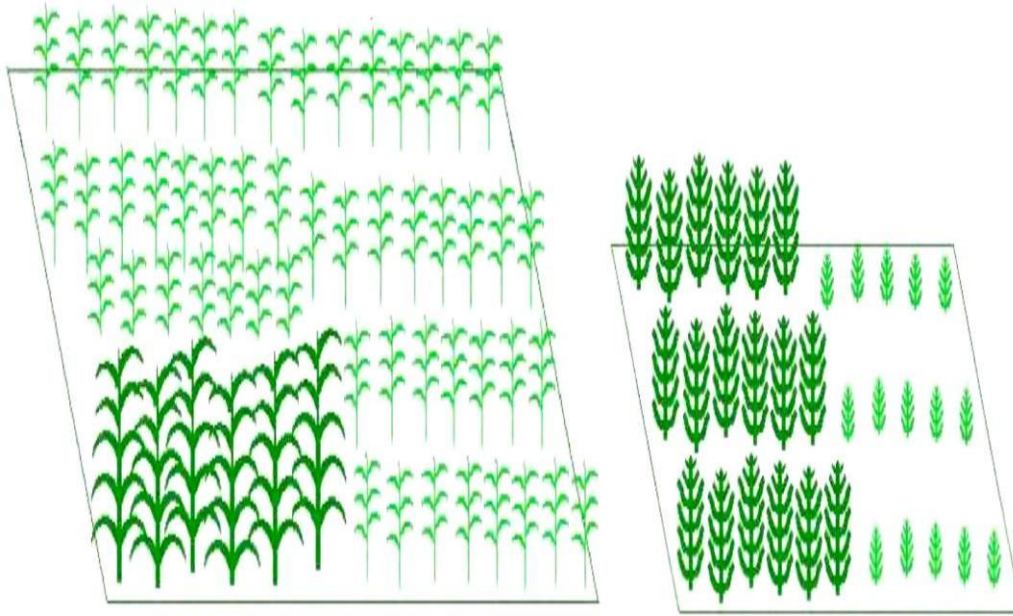


Figure 3. For comparison purpose; to show the difference between fertilized and non-fertilized plots can be split in two (right)



Figure 4. Corn plots without (left) and with urine fertilizer (right) in Zimbabwe. The adjacent plots allow direct visual comparison of results. (Photo by Peter Morgan with permission) (CREPA, 2007).

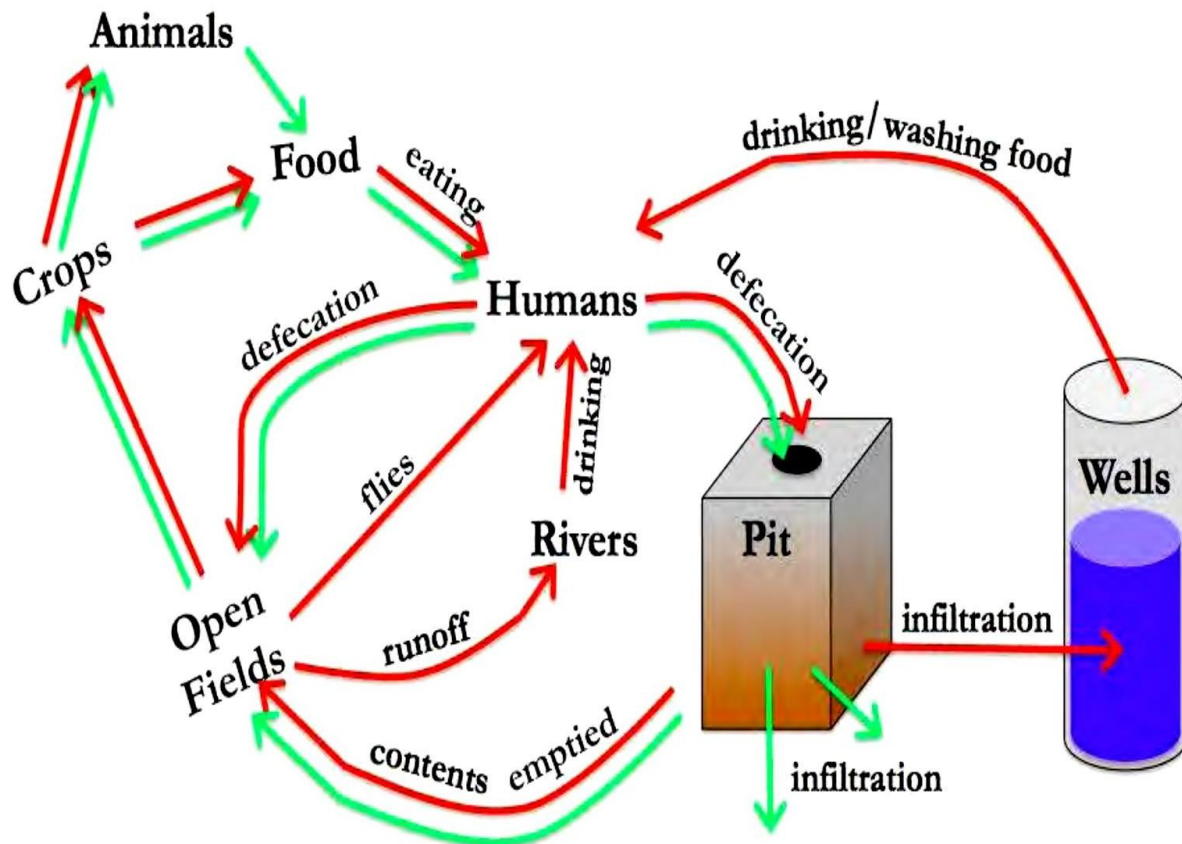


Figure 5. Nutrient and pathogen travel in typical developing world sanitation systems, with people defecating in pits or fields. Green arrows indicate nutrient travel; red arrows indicate pathogen travel.

Source; Ray (2010)

2. 9. IMPACT OF ORGANIC MATTER ON SOIL PHYSICAL PROPERTIES

Soil structure and aggregate stability: soil structure stability refers to the resistance of soil to structural rearrangement of pores and particles when exposed to different stresses (e.g cultivation, trampling/ compaction, and irrigation). Tisdall and Oades (1982); Oades (1984), and Carter and Stewart (1996) reported that addition of OM can not only reduce bulk density (Db) and increase water holding capacity, but also effectively increase soil aggregate stability. Ander and Carter (1996) noted that the amount of water – stable aggregate (WSA) was often associated with SOC content, and that labile carbon was often positively related to macro-aggregate stability. Kay and Anger (1999) reported that a minimum of 2% SOC was necessary to maintain structural stability. Boix-Fays et al (2003) showed that a threshold of 3-3.5% SOC had to be attained to achieve increase in aggregate stability.

Water holding capacity: An important indicator of soil physical fertility is the capacity of soil to store and supply water and air for plant growth. De Jong (1983); Hayness and Naidu (1998) found an increase in water content with increasing SOC content and Wolf and Snyder (2003) stated that an increase of 1% SOM can add 1.5% additional moisture by volume of FC. Emerson and McGary (2003) showed that per gram of additional carbon at -10 kPa suction, a 50% increase in water content was achieved. They suggest that the organic carbon from exudates (gel) from ectotrophic mycorrhiza would bond soil particles which would result in a change in the size of the pores and a change in water retention at -10 kPa.

Soil Colour: Generally, good soil conditions are associated with dark brown colours near the soil surface; which is associated with relatively high organic matter levels, good soil aggregation and high nutrient levels (Peeverill *et al*, 1999).

2. 9. 1. EFFECTS OF ORGANIC MATTER ON SOIL CHEMICAL PROPERTIES

Cation Exchange Capacity (CEC): A high CEC is regarded as favourable as it contributes to the capacity of soils to retain plant nutrient cations. Functional groups of SOM have been associated with an increase in CEC_r (Oades *et al*, 1989). Oades *et al.*, (1989) observed an increase in CEC with increase in soil organic matter.

Buffer Capacity and pH: Soil buffering is considered to be an important aspect of soil health, as it assures reasonable stability in soil pH. Buffering at intermediate pH value (5-7.5) is mainly governed by functional groups of SOM which act as sink for H^+ and OH^- . The importance of SOM to maintain fairly stable pH values, despite acidifying factors, was documented by Cayely *et al*, (2002).

Adsorption and Complexation: Adsorption of SOM on clay particles is an important mechanism for the protection of SOM from decomposition. Complexation of inorganic materials by SOM have important ramifications for soil fertility as it may increase the availability of P by blocking potential adsorption site of Fe and Al as well as Ca (Oades *et al*, 1989).

McGrath *et al.* (1988) reported that increase concentrations of SOM depress the concentration of heavy metals such as Cupric ions. Humic acids have been shown to be important in inhibiting the formation of thermodynamically stable Ca-phosphate (Alvarez *et al*, 2004).

2. 9. 2. BIOLOGICAL FUNCTION OF SOM

The biological function of SOM are primarily to provide a reservoir of metabolic energy that drives biological process, supply macro- and micro- nutrients and to ensure that both energy and nutrients are stored and released in a sustainable manner. Importantly, biological processes in turn influence both soil chemical and soil structural properties as they greatly affect soil structure and soil redox reactions.

Baldock and Nelson (1999) stated that one of the most fundamental function of SOM is the provision of metabolic energy which drives soil biological processes

Soil Resilience: The resilience of a soil is really a measure of the functionality of the whole ecosystem. It is governed by the adequate performance of physical, biological and chemical functions, which in turn is to a large extent determined by the SOM content and its chemical composition.

2. 9. 3. SOIL ORGANIC MATTER AND CROP PRODUCTION

Although there is a considerable variation in the nutrient composition of organic manures depending mainly upon the source, handling and management, the main nutrients supplied are N, P, K, Mg, Ca and a host of micro nutrients (Lombin et al; 1991). Esu (2005) reported nutrient composition of organic manures as N, P, and S as well as micro nutrient elements as B, Cu, Mo, Zn, Mn, Fe and Cl (Table 5). Cook (1982) reported that an average dressing of 10tonnes ha⁻¹ of farmyard manure would supply about 50 kg N ha⁻¹ and 50 kg K ha⁻¹. On crop yields, organic fertilizers have been reported to influence crops performance significantly. Okpara and Mbagun (2003) reported a significant increase in maize yield over the control. Agboola (1978) reported that at 1% organic matter level in the soil, cowpea yield increased from the addition of 10 Kg N ha⁻¹ but at 2, 3, and 5% soil organic matter level, there was no response to nitrogen fertilizer as organic matter met all the plant requirements as shown in Table 6. Alofe et al., (1995) reported that poultry manure application significantly increased soybean yield over NPK fertilizer.

Table 5. Nutrient Composition of Soil Previously Treated With Poultry Manure and NPK Fertilizer.

MANURE	O.M (%)	N (%)	P (Mg/Kg)	K (Cmol/Kg)	Ca (Cmol/kg)	Mg (Cmol/Kg)
0t/ha	1.5	0.07	340	0.32	2.0	2.8
10t/ha	2.0	0.10	380	0.37	2.1	3.6
20 t/ha	2.2	0.11	440	0.46	2.2	4.4
30 t/ha	2.3	0.11	500	0.41	2.3	4.8
40 t/ha	2.3	0.12	580	0.51	2.6	5.2
50 t/ha	2.7	0.13	640	0.60	3.9	7.2
NPKc	1.8	0.09	360	0.45	1.5	3.2
NPKs	2.1	0.11	420	0.41	0.9	1.6

Source: Adenawoola and Adejoro (2005)

Table 6. Average Effect of N and Soil Organic Matter on The Yield of Ife-Brown Cowpea.

Treatments	Percentage Soil Organic Matter				
	0.5%	1%	2%	3%	5%
No N	800c	1200b	1700a	1750a	1800a
10KgNha ⁻¹	1300b	1650a	1800a	1700a	1750a
20 KgNha ⁻¹	1850a	1600a	1750a	1800a	1700a
50 KgNha ⁻¹	1670a	1700a	1800a	1650a	1800a
100 KgNha ⁻¹	1750a	1800a	1800a	1750a	1800a

Source: Agboola, (1978)

Table 7. Chemical Composition Of Selected Animal Wastes.

TYPES OF ANIMAL WASTE	PERCENTAGE DRY WEIGHT						PPM					
	N	P	K	Ca	Mg	S	Mn	Fe	B	C u	Zn	Mo
BROILER LITTER	2.3	1.1	1.7	2.0	0.4	0.4	272	1244	33	29	128	13
HEN LITTER	2.0	1.9	1.9	3.4	0.5	0.5	333	1347	28	31	120	14
DAIRY COW	2.7	0.5	2.4	1.6	0.6	0.3	56	222	83	28	83	6
FATTENING CATTLE	3.5	1.0	2.3	0.6	0.5	0.4	23	182	91	23	68	2
HOG	2.0	0.6	1.5	2.0	0.3	0.5	72	1002	143	18	215	4

Source: Esu, (2005)

In another experiment, Ogeh, (2010) reported that the use of Almond leaf as manure increased the plant height, leaf area and grain yield of maize. Kekong et al; (2008) investigated poultry droppings and cow dung and reported that application of these manures as organic fertilizers significantly increased the yield of garden egg over

the control in addition to the improvement in soil bulk density, porosity and moisture content. With or without the availability of fertilizer, Vanlauwe (2000) stated that as an obligate starting point, organic matter management remains a corner stone for successful farming in many areas of the tropics.

Crop productivity in tropical soils can be achieved by a combination of management strategies, among which the development of an efficient and effective nutrient cycle plays an important role. Increasing soil organic matter has the added benefit of improving soil quality and thereby enhancing the long term sustainability of agriculture (Laird et al., 2001).

2. 9. 4. EFFECT OF ORGANIC MANURE ON GROWTH AND YIELD OF MAIZE (*Zea mays* L.)

Declining soil fertility has been identified as the fundamental cause of declining crop yields in many parts of Africa (Sanchez et al., 1997). Inorganic fertilizers have been used as a way of sustaining soil productivity. However, the extent to which farmers can depend on this input is constrained by unavailability of the right type of inorganic fertilizers, at the right time, high cost, lack of technical know and lack of access to credit (Chude, 1998). This has attracted the attention of soil scientists towards making use of organic materials for improving the physical and chemical properties of soil for profitable crop production (Somani and Totawat, 1996).

Sonetra et al., (2002) suggested that subsistence farmers should apply organic manure directly to the soil as a natural means of replenishing nutrients in order to improve soil fertility and yield of crops. Manures contribute to about 50% to 60% increase in productivity of food grains in many parts of the world, irrespective of soil and agro-ecological zone (DIPA, 2006).

Reijntjes et al., (1992) and Adepetu et al., (2005) reported that amendment of soil with different organic material enhanced growth and yield of crops.

Several organic materials such as cattle dung, poultry dropping, pig dung and refuse compost have been recommended to subsistence farmers in West Africa as soil amendment for increasing crop yield (Sobulo and Babalola, 1992; Ismail et al., 1999; Olayinka, 1996 and Olayinka et al., 1998).

Enujeke (2013) reported that poultry dropping and cattle dung increased root growth of maize and increased grain yield. A study by Adeniyi and Ojeniyi, (2005); Eziebikwe et al., (2009) reveal that poultry manure improve growth and yield of maize relative to no fertilizer.

Municipal wastes were reported by Movahedi et al., (2000) to have reduce soil temperature, increased soil water, nutrient status and the yield of maize at temperate soil. Cattle dung has been reported by Subedi and Gurung, (1991) to contain 0.3-0.4% N, 0.1-0.2% P, and 0.1-0.3% K. Several research findings has proven cattle dung applied at the rate of 10t/ha to cowpea plant resulting in increased plant height, leaf area, pod number and pod weight.

Walls-Thumma (2000) noted that livestock manure contains nitrogen which encourage rapid and healthy growth in plants. Ojeniyi et al., (2001) found that yield of vegetable crops and nutrient were improved by woodash in Southeasten Nigeria.

2. 9. 5. THE NEED FOR SOIL AND WATER MANAGEMENT IN AGRICULTURE

Proper management of tillage systems, crops residues and water use, to build healthier soils with improved structures to better manage agricultural activities and its resources is of crucial importance. Since soil is a medium for plant growth, it usage determines the efficiency and productivity of any agricultural enterprise. Hence, there is need for organise soil and water management practices. Because wrong use of the soil may result to long term degradation of the land which is a huge lost to agricultural productivity of food, feed and raw materials for our industries.

Justification for Soil and Water Management

Soil and water management plays a crucial role in any agricultural production. Soil stands as a medium for plant growth. Some of the cultural practices like wrong method of tillage have a negative effect on the soil structure and its biological life which reduces its efficiency for production. Correct crop production management must look into the practices that will help conserve soil moisture and keep the land away from any form of degradation.

Soil Water Management

This involves all operations, practices and treatment used to protect soil moisture for plant use in other to enhance its optimal performance and yield. It looks into practices that maintain good soil structure such as ploughing, maturing, drainage and irrigation.

2. 9. 6. SOIL WATER CONSERVATION

It is a management practise that seeks to conserve moisture present in the soil for crop utilization. It can be looked as a set of management strategies for prevention of soil being eroded from the earth's surface or becoming chemically altered by over use, acidification, salinization or other chemical contamination. Conservation of soil moisture for plant use involves practices that will enhance valuable soil properties such as soil structure, porosity and aeration. Some of such practices include mulching, manuring, cover cropping and afforestation.

Aims/objectives of the Survey

- To reduce erosion hazards and land degradation water conservation.
- To improved seeds and locally available organic manures are provided to them.
- To ensure productivity on a sustainable basis.

- To provide safe disposal of surface runoff.
- To improve soil health and tilt.
- To maintain soil fertility
- To restore soil fertility
- It makes the Agricultural process an economic one
- It help to increase yield
- It protects the soil.

2. 9. 7. SOIL WATER (MOISTURE)

Soil moisture is the water present in the soil, that water which is available and useful to plants and microorganisms. The ultimate source of moisture in the soil zone of aeration is precipitation-infiltration process. Soil water is used as a medium of obtaining mineral retained in the soil for plants and microorganisms to use as a medium of obtaining mineral elements as well as for growth. Porosity and slope affect the availability of soil water. Soil texture and structure determines amount of moisture present in the soil.

Subdivision of Soil Water

There are two main subdivisions of soil moisture:

1. The zone of aeration or suspended water
2. Zone of saturation or groundwater

The zone of aeration or suspended water:

Water enters the zone of aeration through infiltration. In this zone, interstices (spaces between soil particles) are occupied by water and air.

Zone of saturation or groundwater:

Water enters into the zone of saturation through percolation and all the rock or soil interstices are filled with water under hydrostatic pressure; air is excluded.

2. 9. 8. CLASSIFICATION OF SOIL WATER

Following Todd (1980), we can classify soil-water into three categories on the basis of concentration in the soil zone. These are:

1. Hygroscopic water
2. Capillary water
3. Gravitational water

Hygroscopic Water

Hygroscopic water is adsorbed from the air and from thin films of moisture on soil particle surfaces. This water is not available to plants because the adhesive force holding it to the soil particles are very large

Capillary Water

Capillary water exist as continuous films around soil particles. The water is held by surface tension but is moved by capillary action and is therefore available to plants.

Gravitational Water

Gravitational water is the excess soil water that drains through the soil under the influence of gravity.

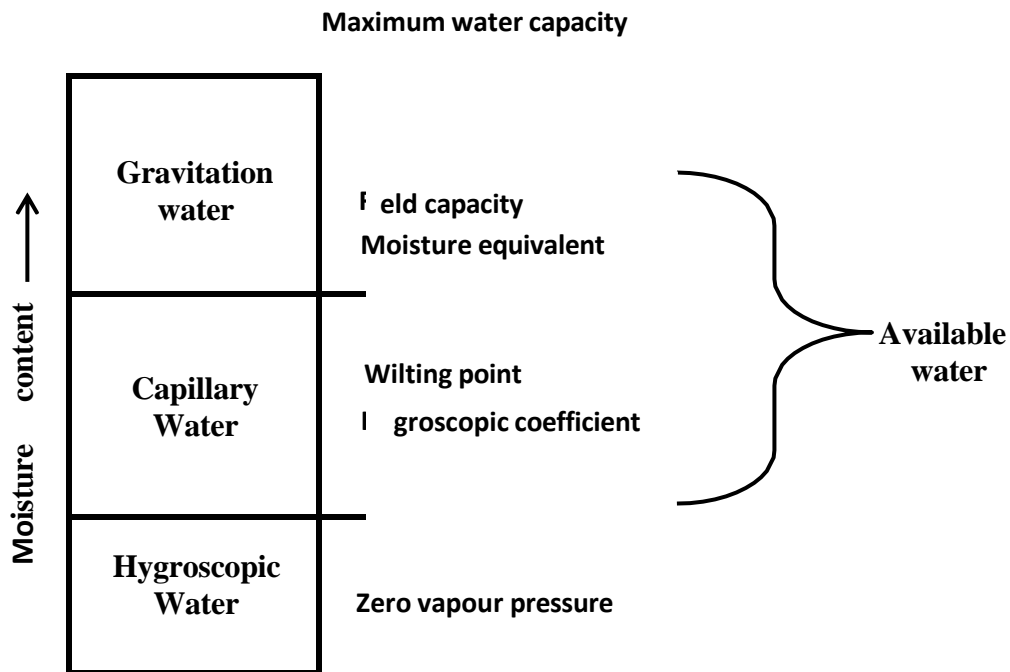


Fig. 6. Subdivision of soil water showing classes and equilibrium point

Measurement of Soil Moisture

There are several methods of determining the water content of soil. the fundamental and most accurate method is the gravimetric method. This method is often used to calibrate other instrument and methods. A soil sample is obtained form

the field, weighed, oven-dried at 105 °C for 24 hours and reweighed. Soil moisture content is obtained as follows using this equation

$$M = \frac{W_w - W_d}{W_d - W_c} \times 100\%$$

where: M is % moisture, W_w is weight of soil including its moisture content, W_d is the weight of the soil after oven-drying it to a constant weight to ensure that all the moisture has been removed, W_c is the weight of the container holding the soil sample.

2. 9. 9. WATER STRESS

Plants experience water stress either when the water supply to their roots becomes limiting, or when the transpiration rate becomes intense. Water stress is primarily caused by a water deficit, such as a drought or high soil salinity. Each year, water stress on arable plants in different parts of the world disrupts agriculture and food supply with the final consequence: famine. Hence, the ability to withstand such stress is of immense economic importance. Plants try to adapt to the stress conditions with an array of biochemical and physiological interventions. This multi-authored edited compilation puts forth an all-inclusive picture on the mechanism and adaptation aspects of water stress. The prime objective of the book is to deliver a thoughtful mixture of viewpoints which will be useful to workers in all areas of plant sciences. We trust that the material covered in this book will be valuable in building strategies to counter water stress in plants.

2. 9. 10. THE EFFECT OF WATER STRESS ON PLANTS

Wilting

The first obvious effect of water stress is wilting because turgor pressure, which inflates plant cells and keeps them erect, is lost. Without this force, the cells inside plant leaves begin collapsing, giving them a limp appearance. As wilting increases, plant cells fully deflate, causing their deaths. Partially wilted plants that are still green may recover if watering is quickly initiated -- the addition of mulch helps to keep soil moisture even.

Reduced Photosynthesis

Photosynthesis is the process through which plants create their own food. The amount of water, sunlight and carbon dioxide available to the plant directly influences the amount of food a plant can produce. When water levels are low due to water stress, photosynthesis can slow or even stop, causing internal food supplies vital to other processes to diminish or disappear – yellowing may also occur if photosynthesis stops completely.

Reduced Respiration

Respiration is the process through which plants break down their food supply for energy to power system processes. When plants are actively growing, they respire heavily, using up food stores quickly. With low water levels reducing the plant's ability to photosynthesize, the plant's system processes slow down, causing reduced or delayed growth and discoloration of leaves, as well as flower or fruit drop, since the plant can't support this extra baggage.

Reduced Transpiration

Hearts pump blood through animal bodies, carrying nutrients and removing waste -- similarly, plants use osmotic pressure to create circulation in their systems. As water moves through the system, vital minerals and nutrients are delivered to different areas of the plant. Water taken up by a plant's roots is slowly drawn up to openings in its leaves called stomas. The stomas release waste products such as oxygen into the environment and bring in carbon dioxide. This release also helps cool plant tissues. In addition, transpiration maintains turgor in plants, keeping cells evenly filled with water. When transpiration is stopped or slowed, the plant begins to die from lack of nutrients, usually from the top down.

Evolutionary Developments

Plants living under constant cycles of drought stress have evolved specialized metabolisms known as C4 and CAM, or crassulacean acid metabolism. Plants with a C4 metabolism photosynthesize faster deeper inside the plant's tissues, protecting water from loss through the plant's stomas. CAM allows plants such as cacti and agaves, as well as some orchid and bromeliads, to close their stomas completely during the day, opening them only briefly at night to exchange gases with the environment. CAM, along with a thick, waxy coating, keeps evaporation to a minimum in these plants to help prevent water stress.

Importance of Soil Water

- Soil water serves as a solvent and carrier of food nutrients for plant growth
- Yield of crop is more often determined by the amount of water available rather than the deficiency of other food nutrients
- Soil water acts as a nutrient itself
- Soil water regulates soil temperature
- Soil forming processes and weathering depend on water
- It helps in the absorption of the mineral salts.
- It helps in the transpiration of the nutrients to other parts of the plant where they are used in various metabolic.
- It is also needed as a raw material during photosynthesis.
- It is essential for plant growth.

- It helps in cooling of crops.
- Microorganisms require water for their metabolic activities
- Soil water helps in chemical and biological activities of soil
- It is a principal constituent of the growing plant
- Water is essential for photosynthesis

Conservation Tillage

Conservation tillage is any method of soil cultivation that leaves the previous year's crop residue (such as corn stalks or wheat stubble) on fields before and after planting the next crop, to reduce soil erosion and runoff. To provide these conservation benefits, at least 30% of the soil surface must be covered with residue after planting the next crop. Some conservation tillage methods forego traditional tillage entirely and leave 70% residue or more. It involves a tillage system that does not invert the soil. It is especially suitable for erosion-prone cropland

Method of Conservation Tillage

Conservation tillage methods include **no-till**, **strip-till**, **ridge-till** and **mulch-till**. Each method requires different types of specialized or modified equipment and adaptations in management.

No-Till and Strip-Till: This involve planting crops directly into residue that either hasn't been tilled at all (no-till) or has been tilled only in narrow strips with the rest of the field left untilled (strip-till).

Ridge-Till: It involves planting row crops on permanent ridges about 4-6 inches high. The previous crop's residue is cleared off ridge-tops into adjacent furrows to make way for the new crop being planted on ridges. Maintaining the ridges is essential and requires modified or specialized equipment.

Mulch-Till: It is any other reduced tillage system that leaves at least one third of the soil surface covered with crop residue.

Zero Tillage

This involves just making a hole that can only contain the seed. It I a seed hole.

Advantage of Zero Tillage

- Effective erosion control strip
- It improves the structure of the soil and porosity
- It encourages moisture conservation
- It improves water use.

Why Practice Conservation Tillage on Your Land?

Environmental Benefits

- ❖ Reduces soil erosion by as much as 60-90% depending on the conservation tillage method: pieces of crop residue shield soil particles from rain and wind until new plant produce a protective canopy over the soil.
- ❖ Improves soil and water quantity by adding organic matter as crop residue decomposes: thus create an open soil structure that lets water in move easily, reducing runoff.
- ❖ Conserves water by reducing evaporation at the soil surface.
- ❖ Conserves energy due to fewer tractor trips across the field.
- ❖ Crop residue provides food and cover for wildlife.

Practical Benefits of Conservation Tillage

- Fewer trips the field saves time and money (lower fuel, labour and machinery costs) and reduces soil compaction that can interfere with plant growth.
- Optimum soils moisture, enhancing crop growth in dry periods or droughty soils.

Agricultural Methods of Soil Conservation

Terrace Farming

This type of farming uses the topography of the land to slow water flow through a series of terraces. These manipulations of the water flow prevent it from gathering speed and washing soil away from lands.

Practice No Till Farming

With no till farming are allowed to remain rather than being plough under at the end of the season. This practise keeps soils anchored in placed rather than travelling bare ground exposed to wind as water.

Maintaining The Soil pH

The measurement of the soils acidity or alkalinity is done by measuring the soil pH levels. Soil gets polluted due to addition of basic acidic pollution which can be countered by maintaining the desirable pH of soil.

Practice Contour Farming

Contour farming replicates the effect of terrace farming but farming ob a smaller scale. Rather than planting crops in straight vertical rows, crops are planted following the contour of the landscape. Crops planted up and down hillsides creates pathways for water to flow crops planted parallel to the land slow the flow of water that prevents soil erosion.

Practice Of Crop Rotation

Crop rotation is the conservation method where a series of different crops are planted one after the other in the same soil area or land. This is done to prevent the accumulation of pathogens which occur if the same plants are grown in the soil again and again and also depletion of nutrients.

Soil Organism

Without the activities performed by soil organism, the organic material required by plant litter and won't be available for plant growth. Using beneficial organisms like earthworms helps in aeration of soil and makes the macro nutrient available for the plants, thus, the soil becomes more fertile and porous.

Salinity Management

In this method, excessive collection of salt in the soil has harmful effect on the metabolism of the plant. Salinity in soils is caused by irrigating the crops with salty water. During the evaporation process the water from the soil evaporates leaving the salt behind causing Salinization. Use of humic acids may prevent excess Salinization. It fixes both anion/cation and eliminates them from root zones.

Re-Established Forest Covers

The re-establishment of forest covers provides an extensive, tree-root network that offers a long – term solution to soil erosion. It can function both as a windbreak and a mean to anchor soils in place.

Plant Windbreaks

Wind breaks prevent soil erosion by showing the force of the wind over open ground. You can plant trees or shrubs in your windbreaks. In addition to preventing erosion, these plantings will prevent snow from drifting your crops into the road. They can also protect your home from wind damage.

Restore Wetlands

Wetlands are one of the most effective ways to prevent soil erosion. Wetlands acts as natural sponges absorbing rain water and preventing it from carrying the soil away. They also provide a habitat for birds and other wildlife and help prevent water pollution.

Practice No Till Farming

With no till farming are allowed to remain rather than being plough under at the end of the season. This practise keeps soils anchored in place rather than allowing bare ground exposed to wind as water.

Maintaining the soil pH

The measurement of the soils acidity or alkalinity is done by measuring the soil pH levels. Soil gets polluted due to addition of basic acidic pollution which can be countered by maintaining the desirable pH of soil.

Soil Erosion

Erosion is the process of detachment of soil particles either by RAIN, WIND or GLACIER which are the three basic agent of erosion. Soil erosion is a form of soil degradation along with soil compaction, low organic matter, loss of soil structure, poor internal drainage, Stalination and soil acidity problem. Soil erosion is naturally occurring on all land. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks.

N/B : Every kind of erosion is traceable to tillage method. Soil erosion leads to land degradation if not controlled.

Types Of Soil Erosion

The following type of erosion are briefly explain such as:

Splash Erosion – this is the first of the erosion process. It occurs when rain drops hit bare soil. The explosive impact breaks up soil aggregates so that individual soil particles are “splashed” onto the soil particles can rise as high 60 cm above the ground and move up to 1.5 metres from the point of impact.

Sheet Eroosion – sheet erosion refers to the uniform movement of a thin layer of soil across expanse of land devoid of vegetable cover, raindrop, detach soil which go into solution as runoff occurs and are transported downstream to a point of deposition. Deposition occurs when runoff slows to the point where particles can no longer remain in suspension.

Gully Erosion – Rill erosion evolves in gully erosion as duration or intensity of rain continues to increase and runoff volumes continues to accelerate. A gully defined as a scoured out area that is not crossable with tillage or grading equipment.

Tunnel Erosion – this occurs when surface water moves into and through dispersive sub soils. Dispersive soil are poorly strutted so they erode when wet. The tunnels starts when surface water moves into the soil along cracks or channels or through rabbit burrows and old tree root cavities.

Tillage Erosion – Tillage erosions from the top of the field down hard, exposing sub soil at the crest while burying soil at the bottom. After many years of tillage, top soil accumulates at the production and increased yield variability can be huge.

Factors that determine the rate of erosion

- ❖ Mineral :- it consist of 45%
- ❖ organic matter:- it consist of 5%
- ❖ Water flow:- it consist of 25%
- ❖ Air:- it consist of 25%

Forms Of Soil Erosion

1. *Normal Or Geological Erosion:*

This erosion takes place under natural condition when the land still have it vegetative growth not remove by the activity of man, it is a slow process which occur in many condition and the soil loss will be replace by soil formation.

2. *Accelerated Erosion*

This type of erosion comes as a result of the activities of man that is upsetting the balance between the soil vegetative cover of the land and the erosion of the various agents. This type of erosion is very destructive in nature.

Note: Clay soil is difficult to transport but easy to detached while sandy soil is difficult to detached but easy to transport.

Fine particles are carried downstream but **Hard particles** are carried upstream.

- **Soil surface roughness**- rough or rigged soil surface offer little resistance to the wind.

Soil Particle Movement Caused By Wind Force

Particle movement in the soil is as a result of wind forces exerted against the surface of the ground. For each specific soil type and surface condition there is a minimum velocity required to move its soil particles called the **threshold velocity**. Once this is reached, quantity of soil moved is deposited upon the particle size, the cloudiness of particle, and wind velocity itself. This is also a form of serious land degradation if not control.

Ways sediment can be moved

These are the three types of soil movement that occur during wind erosion

- ❖ By Suspension
- ❖ By Siltation and;
- ❖ By Creep.

Suspension

This occurs when very fine dirt and dust particles are lifted into the wind. The can be thrown into the air through impact with other particles or by the wind itself.

Siltation

The major fraction of soil moved by the winds is through the process of siltation. In siltation, fine particles are lifted into the wind and travel horizontally across the surface increasing in velocity as they go. Soil particles moved in this process of siltation can cause severe damage to the surface and vegetation.

Creep

The large particles which are too heavy to be lifted into the air are moved through a process called surface creep. In this process, the particles are rolled across the surface after coming into contact with the soil particles in siltation.

Note: surface texture is the best keys to wind erosion protection properly manage crop residues, carefully timed soil tillage, and accurately placed crop soil barriers can all effectively reduce wind erosion.

Causes Of Soil Erosion

- Tillage method
- Land use
- Climate
- Soil
- Landforms
- the intensity of rain and run-off
- Soil erodibility i.e. the ability of soil to resist erosion. Whether the soil is sandy, loamy or clay.
- The slope gradient and length. The steeper the slope of a field, the greater the amount of soil loss from erosion by water.
- If there are no vegetation cover on the land
- Soil surface roughness: - soil surface that are not rough or ridged offer little resistance to the wind.
- Lack of windbreaks (trees, shrubs, residue e.t.c) allows wind to put soil particles into wind.
- If the soil lacks the ability to retain water.

Factors Affecting Erosion

- Vegetation
- Topography
- Climate
- Soil texture and structure

Measures Of Soil Moisture

- Increases the surface roughness

- Reduction of wind erosion
- Planting of trees that act in wind break.

Damage Caused By Soil Erosion

- It removes top soil valuable for agricultural production
- It washes away soil humus
- Total loss of soil nutrient
- It renders land useless for agricultural use and profile
- It affects soil particles such as structure, texture and profile.
- It exposes non fertile sub soil as the red soil in the tropical soil (Laterite) in its wake.

Prevention And Control Of Soil Erosion

Prevention of erosion can be achieved through the following practises or methods of soil conservation

- a) Crop rotation
- b) Controll ed grazing via maintenance of carrying capacity.
- c) Contour ploughing
- d) Afforestation
- e) Cover cropping
- f) Terracing
- g) Strip cropping
- h) Fallowing
- i) Soil additives
- j) Irrigation.
- k) Plant residue
- l) Retardation
- m) Transpiration
- n) Microbial activities in the soil

Universal Soil Loss Equation

Due to impact of erosion on agricultural and non-agricultural land the Universal soil loss equation (USLE) was hailed as one of the most significant development in soil and water conservation in the 20th century. It is an empirical technology that has been applied around the world to estimate soil erosion by raindrop impact and surface rainfall.

The universal soil loss equation state: $A = R K L S C P$ provides a quick approach to estimating on term average annual soil loss (A). He equation comprised of six factors $A = R K L S C P$

where:

A = annual soil loss;

R = rainfall and runoff;

K = soil erodibility;

S = slope steepness;

C = Cover and management;

P = support practice.

Drainage

Drainage is the artificial removal of surface and subsurface water from a particular area of land. Many agricultural soils need drainage to improve production or to manage water supplies.

Types of drainage

1. Land drainage
2. Field drainage

Land Drainage

This is a large scale drainage when the objectives is to drain surplus water from a large area by such means as improving the flow of streams and river, excavating large open drains, erecting dykes and levees and pumping. Scheme of this type is appreciated with large areas of low lying land, frequently in coastal areas, such as schemes are major civil engineering works.

Field Drainage

This is the removal from agricultural land, excess water which might otherwise restrict crop growth. Field drainage is categorised into surface and sub-surface drainage

Surface drainage

Is a diversion from or orderly removal of excess water from the surface of the land by means of improved natural or constructed channels.

Sub-surface drainage

Sub-surface or ground water drainage refers to the outflow or artificial removal of excess water from within the soil, generally, by lowering the water table or preventing its rise.

Factors Limiting The Practise Of Drainage

- a) Drainage is expensive to establish and maintain
- b) The size of farm land can be reduced

- c) The reserve water is stored and can serve as breeding ground for pest and disease.

Benefits Of Drainage

- it prevents waterlogging
- decreases erosion and enhances water infiltration into the soil
- it reduces soil salinity
- Drainage improves the soil structure
- Drainage provides a wider choice of crops which can be grown.
- Drained soil as better aeration and this lead to more activities by microbe, earthworm and other beneficial organism in the soil.
- Drainage can reduce the incidence of disease, such as liver fluke which thrive in wet condition.
- Drainage has the ability to extend the growing season just like irrigation.

Irrigation

Irrigation is the simply the artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, maintenance of landscape and re-vegetation of distributed soils in the dry areas and during periods of inadequate rainfall.

Why Do We Carry Out Irrigation?

Irrigation is needed for one major reasons which is that of providing enough water to full the deficit arising from the depletion of soil moisture from the combined action of three seperate phenomenon that can hardly be measured accurately which include;

- ❖ Evaporation
- ❖ Transpiration
- ❖ Specialization of H_2O below or beyond the root zone.

The phenomenon are so definitive and size in their reaction that unless the deficit they create in soil moisture content is replenished, crops cannot do well. Irrigation scheduling has been defined as the determination of when and how much water to apply (Martin et al., 1990; Howell and Meron, 2007; Hengeller et al., 2011). Scheduling when we can apply water on our crops is one to avoid water stress in crop production and in-turn add to soil productivity, as much water in the soil can lead to water-log soil, hence hindering soil productivity and sustainability

Types Of Irrigation

Irrigation can be group into:

- ❖ Surface (tension) irrigation

❖ Sub-surface irrigation

Surface Irrigation

Is the method of application of H_2O from the surface as above soil surface. The following types exist under it:

- Flooding
- Border
- furrows and
- Sprinkler or overhead irrigation.

Flooding Irrigation – in this method of irrigation, water to be supplied on the field is channelled from the source using conduct, piping, canal and all forms of channels from the field and on getting to the field. The control of H_2O within the field is very tedious if measures are not taken, the farm can be flooded. It is also associated with some diseases.

Basin Irrigation – is one of the most practical irrigation systems by farmer. In this method, the field is divided into different compartment or units, so that each has a wealthy levelled surface, small bond of earth 30-50 cm high normally called level fund are constructed with inter and outlet controls for water.

Border Irrigation – is suitable for large for field unit of 4.0 ha or more. The field is divided into series of strips, 3-30 m wide, and 100-800 m in length by border low bands, even moderate slope along the length, the system requires a large flow of H_2O . The levels forming the field to the strips should be 29-250 m high after settlement and triangular in pore session.

Furrow Irrigation – in this method, small channels normally called furrow carry H_2O down or across the slope. The method is the best suites to give moderately permeable soils with uniform relatively flat scope and to crops which are cultivated in row such as vegetables, tomato, cotton, potato and maize.

Sprinkler Irrigation – is a method in which H_2O is applied above plant forages high enough so that H_2O would be distributed freely and without obstruction.

Sub-Surface Irrigation

It consists of capillary irrigation systems and drip or trickler irrigation.

Capillary Irrigation – in capillary irrigation system, water is delivered to crops by means of capillary. Thus, water table is formed beneath the root zone and water flows freely underground. As a result of surface tension properly of water and soil moisture tension, water closer through the process of capillary for plants to utilize.

Drip Or Trickler Iirigation – in this case, irrigation water is applied through narrow plastic tubes stuck in by the side of the plant being irrigated. Thus, water is applied directly to the base plant and there is little wastage as the case may with other method or in constant to other methods. Water application can be caught by more than 50% using this method.

Importance/Advantages Of Irrigation

- Irrigation enables us to grow crops where it would have been impossible due to lack of water for e.g. in arid regions of the world.
- Irrigation encourage agricultural mechanization which in turns increases output, improves human drudgery, imposes time of agricultural operation.
- It helps increase the world palm of food and fibre for consumption and industries.
- Irrigation leads to greater and adequate utilization of land area.
- It provides employment opportunities especially for the industry such as engineers, technician, agriculturalist and other field related to agriculture.
- It makes all year round farming possible.
- Ti makes up for inadequacy of rain water.
- It encourages increase output.
- It helps to reduce soil Salinity or saltiness.
- Generally, it increases the living standard of the people.

Problems Of Irrigation

- ❖ To carryout irrigation effort in terms of labour requirement and cost is high
- ❖ Depletion of underground aquifer from exploiting water for irrigation purposes.
- ❖ Completion for surface water right, thus can assured conflict demonstrations, sometimes internationally.
- ❖ Attraction and breeding of insect and pest.
- ❖ Build up of salts to toxic levels on the soil surface in areas of high evaporation. This will require leaching to remove the salts or a method of drainage to wash the salts away.

Conditions For Carrying Out Irrigation In A Land

- ❖ Adequate water supply
- ❖ Sufficient fund for the project
- ❖ Technical know how
- ❖ Good maintenance culture
- ❖ Adequate power supply

Where Can We Get Irrigation Water?

- Wells

- River
- Aquifer –a layer of rock or soil that can absorb and hold water which can be exploited.
- Spring
- Lake
- Snow pack
- Rain water (harvested and stored in cistern).

CHAPTER THREE

3. SOIL SURVEY AS A MANAGEMENT ACT TOWARDS SOIL FERTILITY IMPROVEMENT

3.1. INTRODUCTION

As soil is essential to human survival, proper utilization of land by a good farm survey, design and land use planning is required. Surveying of soil or soil mapping is the process of classifying soil type's properties in a given area and encoding such information. It applies the principles of soil science, and uses knowledge from the geomorphology, theories of soil formation, physical geography and analysis of vegetation and land use patterns. Primary data for the soil survey are acquired by field sampling and by remote sensing.

Effective and efficient use of land in Agriculture is a function of a good farm survey. Farm planning entails the drawing or outlining of a farmstead and the arrangement of land for proper usage without the risk of land degradation. Information in a soil survey can be used by farmers to help make decision, plan farming strategies and even determine a particular crops to plant.

Man rely on soil for most of his needs-(i.e. we rely on it for production of food, fibre, timber and energy crops, even for noon agricultural purposes). Hence, it is important that we survey, plan and design our selected site before farm establishment so we can obtain a long-term productivity, sustainability and good health of the soil for maximum production.

3.2. MEANING OF SOIL SURVEY / SOIL MAPPING

Surveying of soil looks into a systematic examination, description, classification and mapping of the soil as they appear in nature, in different areas. Soil surveying gives crucial researches facts:

1. Which can be used for the determination of the important characteristics of soil in nature.
2. Information used in classifying soils, defining soil types and other classification unit used today
3. Soil survey helps in establishing and plotting maps with regards to boundaries among kind of soils in nature.
4. Soil surveying can aid in predicting the adaptability of a specific crops productivity to a particular soil.

Importance Of Farm Surveying And Planning

1. It guide farmers on choice of tillage method
2. It helps to know the size and hectare of farmland
3. It enables the farmer to make proper use of the land and protect the farm against land degradation

4. It also helps in planning the farm and facilitate the location of facilities, buildings and structure in the farm
5. The inputs like labour, chemicals, seeds, planting materials fertilizers can be determined before actual farming starts.
6. Results from farm survey can be used as collateral for security loans from financial institution.
7. It helps to determine the topography of a farmland
8. With the knowledge of farm survey the farmer can be able to lay his farmland into plots for effective and productive cultivation
9. Farm survey and planning can be used for feasibility study.
10. It helps n determining the value or valuation of the land registry

3. 3. TYPES OF SOIL SURVEY

Soil survey can be sub divided into five (5) major types, depending on the purposes to be served and the degree of detail required for a specific purpose

Exploiratory Survey

Are carried out in very large areas to exploit resources. Example; river, water shed etc. in other word, there are the least detailed and are conducted to show schematically the broad differences in soil conditions about otherwise unknown region, they are normally the first step in nationwide survey. Scales of the map are usually 1:1000 000 or smaller unit is 25 km.

Reconnaissance

Use to study the surface characteristics of the soil. This survey is carried out: to investigate the general soil condition of a large area to slow the relationship among broad soil unit, to locate and give initial assessment of areas, suitable for more intensive studies or development, also for collecting general data on land use differentialities. Publishing scale of map is 1:1000 000 to 250, 000 and cartographic soil unit is 250 hectares.

Semi-Detailed Survey

This type of survey is used for feasibility surveys of arable or multipurpose land developmental project. The amount of information provided here is more than a reconnaissance survey and so could be used for more in-depth studies or intensive land/farm developmental project. It provides the information necessary to allocate land to their major uses. Publishing scale is 1:50,000 and the cartographic soil unit is 25 hectares.

Detailed Survey

Detailed survey generally cover relatively small areas needed for research, detailed project and it useful in some management and pre-urban surveys. A detailed survey should be implemented on a grid system, although full use should be made of those vegetation and topographic features that are related to soil and land management of characteristics. Publishing map scale is 1:10,000-1:25.000 and cartographic soil unit is 5hectares.

Intensive Survey

Intensive surveys are scales larger than 1:10,000. Besides soil series and phases, maps of individual soil properties can usually be produced. For planning irrigation development in areas of intensive farming and agricultural experimental station, surveying at this scale maybe justified but should never be undertaken without knowing who is going to use them and for what purpose. Publishing scale of map is 1:10,000 or larger as the cartographic soil unit is 0.25 hectares.3.3Method Of Carrying Out Soil Survey Soil survey method of carrying out soil survey have been develop but can be grouped roughly into main types such as method of convention work and soil survey with aerial photo interpretation

Method Of Conventional Field Work

Soil survey procedure in which no aerial interpretation is use, it is divided into rigid grid survey, grid survey, free style and loop.

The Rigid Grid Survey

In this method of soil survey, field observations are taken at fixed intervals along transverse which are they cut at fixed (interval) distance from one another. The legend may be set up before or during or after the field work is complicated.

Grid Survey

This method of soil survey is modified form of rigid grid. Transverse are still cut at fixed distances from one another but observations, mode along the transverse where they appear to be a difference in the soil.

Free Style

Here, there is no grid or transverse, you collect the sample where there is difference.

Loop Method

It is carried out in area where there is lot of obstacles i.e. most of the thing is done by assumption.

3. 4. METHOD OF SOIL SURVEY WITH AERIAL PHOTO INTERPRETATION

1) *Photo Preparation Procedure*

In this method, an intensively systematic analysis of aerial photograph is carried out before the survey starts, all interpretation lines which appear to be probable soil boundaries are drawn on the photograph and the photo interpretation map is prepared.

2) *Extra Pollation Procedure*

In this method of survey, the aerial photograph of the whole survey area are analysed systematically, classified and the photo interpretation map is prepared. Field and laboratory investigation of sample areas are carried out and the photo interpretation map is thoroughly checked.

3) *Remote Sensing*

This method is to obtain information about the soil through analysis about an object or land in which you're not in contact with but can obtain information. It can be achieved by Aerial photograph e.g. aeroplane, multi-spectral scanner, sides looking air bone radar.

Other Kinds Of Soil Survey

a) *General purpose soil surveys*

General purpose soil surveys are carried out in enough detailed with sufficient characterization of each mapping unit.

b) *Special purpose surveys*

Special purpose surveys are carried out where the purpose is known or is specific for example irrigation, land reclamation or the cultivation of a particular crop such as maize, rice, groundnuts.

3. 5. WHY DO FARMERS NEED INFORMATION FROM SOIL SURVEY

1. Information from soil survey gives the farmer knowledge about the capability and the suitability of his farm land to an intended use farm enterprise.
2. A farmer needs this information so he can predict the yield of his crops even after planting.
3. Survey facts enables the farmers to take protective management measure of his farm, he can plan against any damage that may be caused due to erosion or flood. As these phenomenon occurs naturally.
4. After surveying the farmer gains knowledge method he can use to tillage the soil during land preparation operation.

Other Users Of Soil Survey Information

- Information about the soil guides an engineer in the choice and selection, project site, so he can do his work more efficiently.
- A geographer uses soil information to study soil formation procedures.
- In the study meteorology soil information is necessary for a station of a meteorological station, buildings and structures.

How To Chose A Scale

A scale - Is a ratio of depicted distance to actual distance.

A publishing scale - Is usually chosen at the planning stage of every survey. A scale is determined by the purpose of the map mainly according to the level of detailed required. On ground of lost, the scale selected will be smallest that adequately maybe the needs of the user. There are cartographic controls to the size and shape of area that can be depicted on a map. The field survey should be conducted on based map 2 to 2.5 times the scale of interest publication, or as required by literature.

Requirement of a good survey

- a) In looking at the survey analysis, the scale of the map should be such that the map is eligible at a distance of approximately 3cm.
- b) The smallest area of a soil unit on the map and the symbol printed in the unit should be clearly visible for easy understanding.

The Basic Principles Of Soil Survey/ Soil Mapping

- a) Before A soil survey is embark on the purpose or aim must be analysis
- b) A soil map must show soils details (all necessary information about the soil)
- c) Land resources do not consist of soils alone
- d) Soil survey is only an aid for decisions making in land use and management practises.

Who Are The Users Of Soil Survey Information

Soil facts or information are use widely. The under listed include some of soil information users:

- a) Farmers - A farmer uses the information to learn how to control erosion, plant, and sie structure in his farm
- b) Agricultural advisory staff (consultant) - They use the information to support agricultural activities like crop-soil relationship.
- c) Research workers - They use the information to run series of researches and experiment
- d) Foresters - Forester can plant trees or do any other activity through the help of survey information
- e) Planning agencies - like in town planning, **survey** information helps for citation of Governmental infrastructures.

- f) Development organization - For Infrastructural development
- g) Engineers - For construction purposes
- h) Private inventors - For consultation and enquires

3. 6. SOIL SURVEY EQUIPMENT

The under listed are some of the commonly used survey equipment:

Prismatic Compass

Description and uses:

- a) It can be used in measuring angular distances during survey
- b) There is a compass card marked in degrees, half degrees, minute and seconds in a clockwise direction
- c) There is the presence of a prism
- d) The compass is used in taking bearing
- e) This is an extremely useful instrument

Arrow Pin

Description and uses:

- a) It is made of steel wires
- b) It is about 30 cm long
- c) One end of the pin curved into a ring
- d) The red cloth enable the pin to be seen from afar
- e) It is used for making chain length as measured.

Core Sampler

It is round in shape and is used for collecting soil samples.

Hand Lens

It is used to detect the boundaries in the profile horizon.

Measuring Pole

Description and uses:

- a) It is used to form 3-4-5 methods of measurement
- b) There are steel tapes and linen tapes
- c) It is marked on one side in metric units and on the other side in imperial units.
- d) The tape is normally wound in a small case from where it is unwounded for use
- e) For making measurement of length and breadth

Beacon Or Pillar

Description and uses:

- a) it is constructed from cement blocks
- b) it is rectangular in shape

- c) the height is about 2ft to 3ft
- d) it is used in making stations or point
- e) it is buried about $\frac{3}{4}$ of its size

Theodolite

Description and uses:

- a) Consist of s tripod stand made of wood or light weight metal.
- b) It is placed on a solid/telescopic leg
- c) There is a lower plate which has graduated horizontal circle
- d) It is used for the measurement of both horizontal and vertical angles
- e) It consists of a tripod, tribrach, lower plate, upper plate, turnnion, telescope, circles and altitudes.

Offset Staff

Description and uses:

- a) It is graduated rod
- b) It is used for taking short off-set measurement
- c) It is about 3m long
- d) There is a telescope link which is 0-3 (30cm) in length
- e) A hook may be attached to the top, which helps in the pulling of chains through hedges

Gunters Chian

Description and uses:

- a) This is surveyor's chain that was used before tapes were discovered.
- b) It is made of steel wines which are dumb-bell in shape.
- c) Each chain is joined together by link of three small rings
- d) A Günter's chain is about 66ft or 20.13m in length.
- e) Each chain is made of about 100links and each link is about 19.8cm or 7.92 inches.

Soil Auger

Description and uses:

This is an iron rod of about 1.2m length with a cylindrical slope at the other end. The cylindrical end is sharp enough to dry inside the soil. It is used to collect soil sample.

Trowel

It is used to collect soil samples for profile pit purpose.

Ranging Pole

Description and uses:

- a) Its length ranges from 1.8,2.4m to 3.0m
- b) It can be either wood or metal
- c) It is either circular or octagonal in shape
- d) It is pointed with different colours of black, red and white.
- e) It is used for making spots and stations

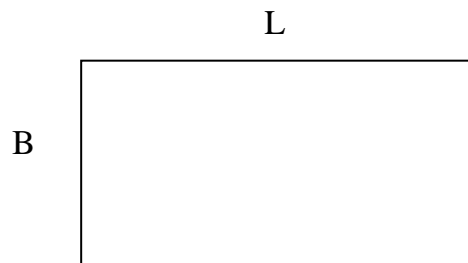
Practical Ways Of Maintaining Survey Equipment

It is essential to take good care of survey equipment in other to maintain it lifespan. The following point gives a guide to how survey equipment can be practically maintained :

- 1) Immediately after usage clean/ wash and dry properly before storage
- 2) Make an effort to grease or oil the metal tip to avoid rusting of metal or steel parts
- 3) If the equipment is already rust painting is required.
- 4) Prepare a repair and servicing schedule to ensure that equipment are working properly.
- 5) Always store all the equipment in a cool and dry place to ensure safety
- 6) Equipment should always be stored in a well organize store, sealed to prevent water (moisture) from entering the room.
- 7) Spoilt equipment should be remove from the store and replace with functional ones, as using spoilt equipment may result to error during reading the equipment.

3. 7. PRACTICAL SOIL SURVEY FIELD EXPERIENCE

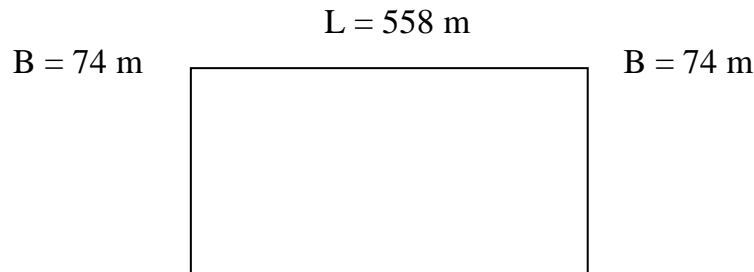
A rectangular shape land was map out at the Cross River University of Technology, and used for this practical survey.



where: L = Length
B = Breath

We started by cutting pecks and placing our ranging poles in a rectangular direction, the total width was 74 m i.e. from the starting point(palm tree). While the length was 558 m which was taking in an opposite direction on the horizontal edge to balance it to an hectare and pecks were pin in point at each position were necessary.

Calculation for the practical survey field



where: L = Length

B = Breath

L = 558 m

Hence, **Area = A**

Since all sides are equal

Then, Area = L (558m) × B (74 m)

Area = 41,292 m²

Finding the total heater of the palm tree

Area of the surveyed field = 41,292 m²

Example of getting a hectare is 100 × 100 = 10,000 m².

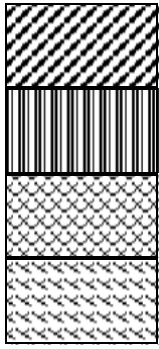
Then, the total hectare Of the palm tree is: $\frac{41,292 \text{ m}^2}{10,000 \text{ m}^2} = 4,1292 \text{ ha}$

3. 8. PRACTICAL FIELD WORK- CONSTRUCTION OF SOIL PROFILE PIT

As required, all practical year students were grouped into three (3) different groups (A, B and C). Locations were assign to each group dig a profile pit. I was the group captain of group A and we dug our profile pit inside our already surveyed field. We dug about 1.8m to met the rock .

➤ Soil profile pit analysis during practical

In group A, the soil horizon discovered were four (4), which are: Horizon O, A, B, C.



O - Horizon (Un decomposed and Partially decomposed organic materials)

A – Horizon (Top soil)

B – Horizon (Subsoil)

C – Horizon (Weathered parent material)

Depth of profile pit = 1.8 m

Length of the profile pit = 3 m

Width of the profile pit = 2 m

Depth of measurement for each soil horizon

Horizon O = 5 cm

Horizon A = 38 cm

Horizon B = 54 cm

Horizon C = 42 cm

➤ Why we dug the profile pit

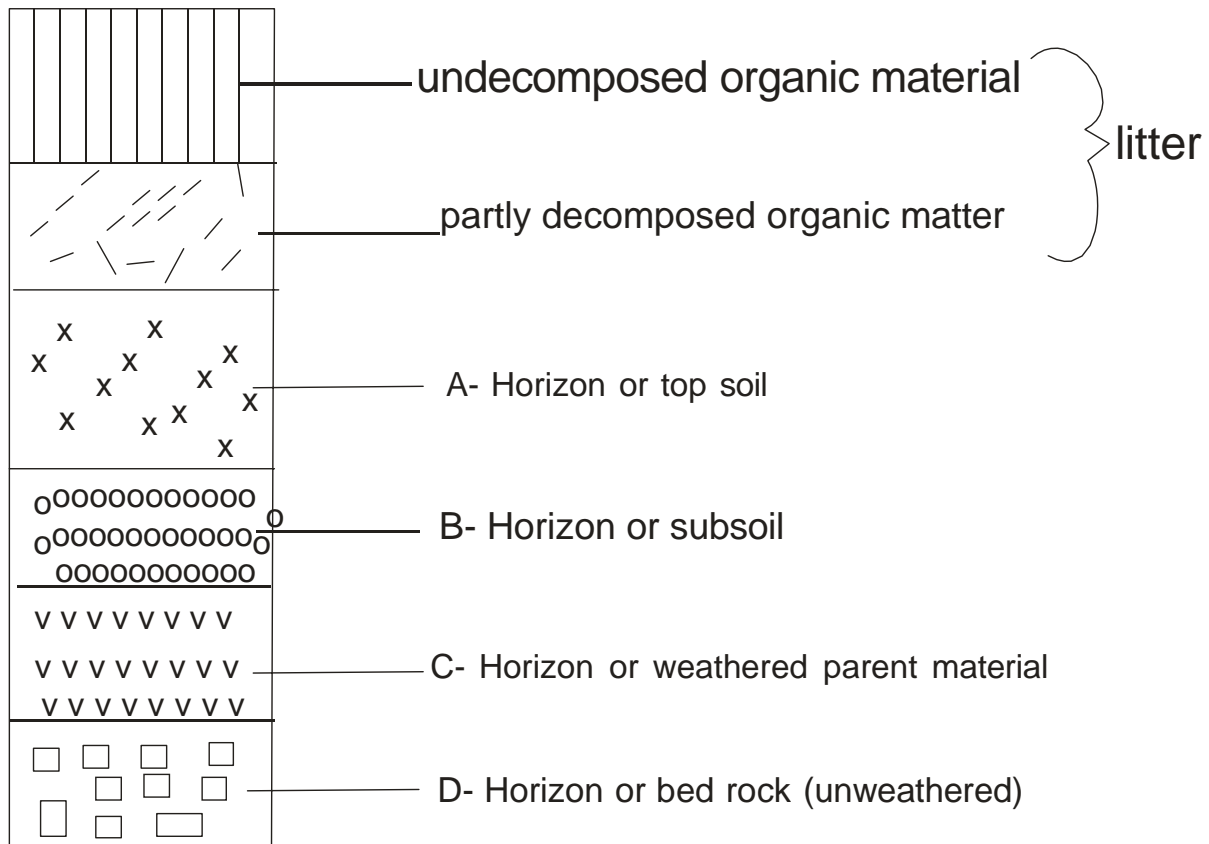
- a) To know the different layers of soil and their depth.
- b) To identify some layers and its function on which plant should grow well.
- c) To see for ourselves the colours, composition, structure and texture of the layers.

Soil Profile Pit

The profile pit is a vertical cross-section of the soil from the ground surface downwards to where the soil meets the underlying rocks. Soil profile pit gives a vertical view through the different layers of the soil to a non-material. The non soil-layer could be considered rock or water table.

Each of the soil layer is term “soil horizon”. Soil horizon differs from one another. Each soil profile ideally is made up of seven horizons. These horizons have different characteristics for identification, using the following properties, colour, organic carbon, texture, structure, etc.

The soil profile diagram



Soil Horizon As They Appear During Practical Observation :

Analysis and description of soil layers and its composition

Horizon 'O' (litter layer)

This horizon is not really a soil but partly decomposed organic matter and litter.

Horizon 'A' (organic matter layer)

The physical/visual observation here is that it is more of organic matter formation. It is dark in colour and contains humus. Forces of addition are found here. It is the border between O and B. It corresponds to the top soil. It has no fixed depth because the all depend on the soil characteristics.

Horizon 'B' (sub soil)

This horizon is called the sub soil. It can be divided into two (2) layers depending on its colour. The upper layer is dark colour and contains coarse sandy loam, fibrous branches, taproot, bacteria, fungi and worm etc. The second layer is yellowish or brownish in colour. It contains sandy loam, little humus, and is the richest part of top soil. It has the highest p^h from that of A Horizon. It is more important to crops e.g. tree crops because it provides anchorage for them. Residual moisture is mostly found here.

Horizon 'C' (weathered parent's material)

It is the bedrock from which the soil has been originated. It is reddish orange, gravelly and contains sandy clay soils. The clay content is very high. Taproots can be seen occasionally. It is consolidated by action of carbonates and silica.

Horizon 'D' (bedrock or unweathered): It is an area in which rocks had not been transformed.

Some Basic Fact About Soil Layers

In chemical composition: - they differ in soil p^H

Biologically : Different soil layers have different soil microbes dwelling in it. they have higher microbes and mineral in the O, A than B and C.

Natural Differences During studies differences in the color from top to bed rock and the depth can easily be seen.

Physical viewing: - they differ in depth, colour, structure, texture and consistency

Importance Of Digging A Soil Profile

- a) To determine the best soil suitable for agriculture.
- b) It determines the level water can be available in the soil for plant uses.
- c) It identifies the part where plant nutrient can be found, that is the top soil.
- d) It shows the richest part of the soil suitable for optimum crop performance

3. 9. Practical Soil Sample Analysis

➤ Collection of soil sample from different soil horizon

Soil samples were taken starting from the lower horizon to the upper horizon, this was to prevent contamination because materials from up can contaminate the lower horizons material. The nutrient content of a soil is being determined by soil analysis using appropriate chemical reagents and other laboratory equipment.

Determination Of Moisture Content, Bulk Density And Porosity Of Soil

As part of the study/course requirement, the three groups (A, B and C) were given different locations to collect soil samples for analysis. Group 'A' was asked to collect soil from the forest opposite the administrative block and from the fourth year practical farm by the swamp area close to where vegetable crops were planted. Group 'A' were given two (2) big cores and two (2) small cores to collect soil sample for determination of moisture content, bulk density and porosity of soil.

Aim Of The Work

- To know the different performance of soil

- To have knowledge of where different crops should be cultivated depending on the moisture content, bulk density and porosity of the soil.

Critical observation during the practical:

- I notice that the cores used for both forest and swamp soil have the same height, radius.
- Empty core weight but different weight measurement in wet soil core.

Labelling Of The Different Core Samples

All the cores for soil sample collection were numbered into two for easy identification and reading. Hence, **A_a, A_b and B_a, B_b** where:

A_a = big core for forest soil

A_b = small core for forest soil

B_a = Big core for swamp soil

B_b = small core for swamp soil

Weight Of Empty Sample Core

(A_a and A_b)

Empty big core **A_a** = 307 g

Empty small core **A_b** = 98 g

Core Used For Collecting Disturb Soil Sample

(A_a and A_b)

Height of the big core **A_a** = 7.3 cm

Height of the small core **A_b** = 5.1 cm

Circumference for big core = 26.6 cm

$$\text{Radius} = \frac{26.6 \text{ cm}}{4}$$

Radius of the big core = 6.65 cm

Circumference for small core = 18.3 cm

Radius of the small core = 4.57 cm

To Get Field Weight For Disturb Soil

(A_a and A_b)

Therefore, weight of big core with disturb soil – empty big core = 977 – 307 = 670g.

670 g is the weight of disturb soil in big core **A_a**.

Therefore, weight of small core with disturb soil – empty small core = $298 - 98 = 200$ g.
200 g is the weight of disturb soil in small core **A_b**.

Weight Of Disturb Oven Dry Soil
(A_a and A_b)

Weight of oven dry soil with big core **A_a** = 951 g
Weight of oven dry soil with small core **A_b** = 207 g

To Get Field Weight For Disturb Oven Dry Soil
(A_a and A_b)

Therefore, Weight of oven dry disturb soil with big core – empty big core = $951 - 307 = 644$ g
644g is the weight of oven dry disturb soil in big core **A_a**.
Therefore, Weight of oven dry disturb soil with small core – empty small core = $207 - 97 = 110$ g
110g is the weight of oven dry disturb soil in small core **A_b**.

Core Used For Collecting Undisturbed Soil Sample
(B_a and B_b)

Height of the big core **B_a** = 7.3 cm
Height of the small core **B_b** = 5.1 cm
Circumference for big core = 26.6 cm

$$\text{Radius} = \frac{26.6 \text{ cm}}{4}$$

Radius of the big core = 6.65 cm

Circumference for small core = 18.3 cm

Radius of the small core = 4.57 cm

Weight Of Empty Core
(A_a and A_b)

Empty big core **A_a** = 298 g
Empty small core **A_b** = 97 g

Weight Of Core For Undisturbed Soil
(B_a and B_b)

Weight of big core with wet soil **B_a** = 959 g
Weight of small core with wet soil **B_b** = 303 g

To Get Field Weight For Undisturbed Soil

(B_a and B_b)

Therefore, weight of big core with undisturbed soil – empty big core = 959 – 298 = 661 g.

661 g is the weight of soil in big core **B_a**.

Therefore, weight of small core with undisturbed soil – empty small core = 303 – 97 = 206 g.

206 g is the weight of soil in small core **B_b**.

Weight Of Undisturbed Oven Dry Soil

(B_a and B_b)

Weight of oven dry wet soil with big core **B_a** = 738 g

Weight of oven dry undisturbed soil with small core **B_b** = 264 g

To Get Field Weight For Undisturbed Oven Dry Soil

(B_a and B_b)

Therefore, Weight of oven dry undisturbed soil with big core – empty big core = 738– 298 = 440 g

440g is the weight of oven dry wet soil in big core **B_a**.

Weight of oven dry undisturbed soil with small core = 264 g

Therefore, Weight of oven dry undisturbed soil with small core – empty small core = 264 – 97 = 167 g

167g is the weight of oven dry undisturbed soil in small core **B_b**.

Moisture Content Disturbed Soil

$$\text{Moisture content} = \frac{\text{field weight} - \text{oven dry soil}}{\text{Oven dry soil}} \times 100$$

For Big Core A_a

Where,

Field weight = 977

Oven dry soil = 951

$$\begin{aligned} \text{Moisture content} &= \frac{977 - 951}{951} \times 100 \\ &= 26/951 \times 100 \\ &= 0.0273 \times 100 \\ &= 2.73 \end{aligned}$$

For Small Core A_b

Where,

Field weight = 298

Oven dry soil = 207

$$\begin{aligned} \text{Moisture content} &= \frac{298 - 207}{207} \times 100 \\ &= 91/207 \times 100 \\ &= 0.439 \times 100 \\ &= 43.9 \end{aligned}$$

Bulk Density (Db) For Disturbed Soil

$$\text{Bulk density (D}_b\text{)} = M_s / v_b$$

Where

M_s = oven dry mass of soil

$$V_b = \pi r^2 h$$

$$\pi = 3.142 \text{ or } 22/7$$

r = radius of core squared

h = height of core

For Big Core A_a

Where, M_s = 951, π = 3.142, r = 6.65, h = 7.3

$$\begin{aligned} \text{Bulk density} &= M_s / \pi r^2 h \\ &= 951 / 3.142 \times (6.65)^2 \times 7.3 \\ &= 951 / 3.142 \times 44.2 \times 7.3 \end{aligned}$$

$$\begin{aligned} \text{Bulk density (D}_b\text{.)} &= 951 / 1,013.79 \\ &= 0.938 \text{ g/cm}^2 \end{aligned}$$

For Small Core A_b

Where, M_s = 165, π = 3.142, r = 4.5, h = 5.1

$$\begin{aligned} \text{Bulk density} &= M_s / \pi r^2 h \\ &= 207 / 3.142 \times (4.5)^2 \times 5.1 \\ &= 207 / 3.142 \times 20.25 \times 5.1 \end{aligned}$$

$$\begin{aligned} \text{Bulk density (D}_b\text{.)} &= 207 / 324.49 \\ &= 0.637 \text{ g/cm}^2 \end{aligned}$$

Porosity For Disturbed Soil

$$\text{Porosity} = 1 - \frac{D_b}{M_s} \times 100$$

Where

D_b = bulk density

M_s = is constant (2.65)

For Big Core A_a

Where, D_b = 0.938, M_s = 2.65

$$\text{Porosity} = 1 - \frac{0.938}{2.56} \times 100$$

$$\begin{aligned} &= 1 - 0.352 \times 100 \\ &= 0.648 \times 100 \\ &= 64.8 \end{aligned}$$

For Small Core A_b

Where, D_b = 0.637, M_s = 2.65

$$\begin{aligned} \text{Porosity} &= 1 - \frac{0.637}{2.56} \times 100 \\ &= 1 - 0.240 \times 100 \\ &= 0.76 \times 100 \\ &= 76 \end{aligned}$$

Moisture Content For Undisturbed Soil

$$\text{Moisture content} = \frac{\text{field weight} - \text{oven dry soil}}{\text{Oven dry soil}} \times 100$$

For Big Core B_a

Where,

Field weight = 959

Oven dry soil = 738

$$\begin{aligned} \text{Moisture content} &= \frac{957 - 738}{738} \times 100 \\ &= \frac{221}{738} \times 100 \\ &= 0.299 \times 100 \\ &= 29.9 \end{aligned}$$

For Small Core B_b

Where,

Field weight = 303

Oven dry soil = 264

$$\begin{aligned} \text{Moisture content} &= \frac{303 - 264}{264} \times 100 \\ &= \frac{39}{264} \times 100 \\ &= 0.147 \times 100 \\ &= 14.7 \end{aligned}$$

Bulk Density (D_b) For Undisturbed Soil

$$\text{Bulk density (D}_b\text{)} = M_s / v_b$$

Where

M_s = oven dry mass of soil

$$V_b = \pi r^2 h$$

$$\pi = 3.142 \text{ or } 22/7$$

r = radius of core squared.

h = height of core

For Big Core B_a

Where, $M_s = 738$, $\pi = 3.142$, $r = 6.65$, $h = 7.3$

$$\begin{aligned} \text{Bulk density} &= M_s / \pi r^2 h \\ &= 738 / 3.142 \times (6.65)^2 \times 7.3 \\ &= 738 / 3.142 \times 44.22 \times 7.3 \end{aligned}$$

$$\begin{aligned} \text{Bulk density (D}_b) &= 738 / 1,014.25 \\ &= 0.728 \text{ g/cm}^2 \end{aligned}$$

For Small Core B_b

Where, $M_s = 264$, $\pi = 3.142$, $r = 4.5$, $h = 5.1$

$$\begin{aligned} \text{Bulk density} &= M_s / \pi r^2 h \\ &= 264 / 3.142 \times (4.5)^2 \times 5.1 \\ &= 264 / 3.142 \times 8.41 \times 5.1 \end{aligned}$$

$$\begin{aligned} \text{Bulk density (D}_b) &= 264 / 134.763 \\ &= 1.958 \text{ g/cm}^2 \end{aligned}$$

Porosity For Undisturbed Soil

$$\text{Porosity} = 1 - \frac{D_b}{M_s} \times 100$$

Where

D_b = bulk density

M_s = is constant (2.65)

For Big Core B_a

Where, $D_b =$, $M_s = 2.65$

$$\begin{aligned} \text{Porosity} &= 1 - \frac{0.728}{2.65} \times 100 \\ &= 1 - 0.274 \times 100 \\ &= 0.726 \times 100 \\ &= 72.6. \end{aligned}$$

For Small Core B_b

Where, $D_b = 1.958$, $M_s = 2.65$

$$\text{Porosity} = 1 - \frac{1.958}{2.65} \times 100$$

$$\begin{aligned} &= 1 - 0.738 \times 100 \\ &= 0.262 \times 100 \\ &= 26.2 \end{aligned}$$

3. 9. 1. Land Use Planning

Land use planning is the scientific focus of the optimum use of land to provide single or multiple results in perpetually to ensure that land is put to its best use.

It is a branch of public policy encompassing various disciplines which seek to order and regulate land use in an efficient and ethical way. It is the human use of land. Land use involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, farm and settlement.

A drawing of the farm stead may therefore be included in the planning. It includes farm house and the buildings near it. This help to design various units and provide place of abode and farming for the farmer.

3. 9. 2. Factors To Consider In Planning And Design Of A Farmstead

Farmstead is the home of farm animals and production centre for plants. The factors considered are:

- Climate e.g. rainfall, temperature, relative humidity, air movement etc.
- Topography or nature of the land.
- Nature of soil and water supply.
- The farmstead.
- Incorrect economic factors.

Objective Of Land Planning

- To determine the characteristics of land.
- To know its possibilities and problems.

Importance Of Land Use Planning

- The farmers can be able to make good and proper use of available land.
- It will enable him to construct each structure or building in a good specific location.
- It enables him to allocate livestock building putting into consideration other structures.
- It makes the farm neat and devoid of pollution.

CHAPTER FOUR

4. SUMMARY AND CONCLUSION

4.1. Summary

The soil is a natural resources base for agriculture and all agricultural practices for the sustenance of man. Our tropical soils are highly weathered, characterized by low CEC and exchangeable bases and fragile. The soils are deficient in nutrients with low organic matter content and inherently infertile and low in productivity.

Inorganic fertilizers are scarce and costly in addition to their negative effects on soil physical and chemical properties. Organic matter are cheap and widely noted to improve the physical, chemical and biological properties of the soils. Organic fertilizers increase the soil nutrient base with various nutrient elements both macro and micro and ultimately increase crop growth and yield significantly on a sustainable basis.

4. 2. Conclusion/Recommendation

From the different studies under this survey, it can be concluded that organic matter is the nerve centre of soil fertility and sustainability of agriculture. The future of agriculture in fertilizer use will lie in the development of organic matter which provide required nutrients as well as enhance soil physical, chemical and biological properties in addition to increased crop yields.

In looking at soil as a major medium for plant growth, which have developed by a long process of weathering and disintegration of rocks then its maintenance should be of great important to mankind because defect like soil erosion which removes valuable topsoil which is the most productive horizon of the soil profile causes food scarcity, low income, and inadequate raw materials for our industries. A good knowledge of soil and water management helps in soil moisture conservation, erosion control, drainage, irrigation and bio-engineering practices which in turn helps to solve human need of daily demand for food and other agricultural including natural resources.

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