Making the Soil and Water Environment Conducive for Plants and Man

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399th Inaugural Lecture

MAKING THE SOIL AND WATER ENVIRONMENT CONDUCIVE FOR PLANT AND MAN

1. PREAMBLE

Mr. Vice-Chancellor Sir, Principal Officers of the University, distinguished guests, ladies and gentlemen. It is with a grateful heart to the Almighty God that I stand before you this afternoon to deliver the **399th** Inaugural Lecture of the Obafemi Awolowo University, Ile-Ife. This is the eighth inaugural lecture to be delivered from the Department of Agricultural and Environmental Engineering of this University.

The inaugural lecture of today titled "**Making the Soil and Water Environment conducive for Plants and Man**" is to formally celebrate the Chair of Agricultural Engineering, which was established for me in 2012. I agree with what King Solomon said in the Holy Bible that "***To everything, there is a season, and a time to every purpose under the heaven"*** and that ***"God has made everything beautiful in its time…" (Ecclesiastes 3:1,14)***. The timing of this inaugural lecture is unique because I believe that 2025 is a landmark year.

Mr. Vice Chancellor Sir, Permit me to briefly share my background and the inspiration behind my research focus. As a final-year student in the then Department of Agricultural Engineering, Obafemi Awolowo University, I specialized in Farm Power and Machinery. My final-year project titled, "**Development of a Low-Cost Incubator**", supervised by Prof. O.A. Ajayi (Former DVC, Admin), won the best project award that year.

Ironically, my interest later shifted to Soil and Water Engineering during my National Youth Service at the Federal University of Agriculture, Makurdi. A prolonged academic strike gave me ample time at the university library, where I developed a deeper passion for the field of Soil and Water Engineering.

I was admitted to the postgraduate program in Industrial Engineering at the University of Ibadan and was also assured of a job at the Nigeria Tobacco Company (NTC) in Ibadan, where I had previously completed my SIWES. Around the same time, I learnt of an opening for a Graduate Assistant at OAU. Two positions were available—Soil and Water Engineering and Farm Structures. Driven by my newfound interest, I applied for the Soil and Water Engineering role and was offered the position.

Choosing between Ibadan and Ife was tough, but by divine guidance, I accepted the appointment as a graduate assistant in this great University, which marked the beginning of my journey in the field of Soil and Water Engineering.

In this lecture, apart from presenting detailed descriptions of the keywords, I intend to present my contributions to research in the general area of Soil and Water Engineering while focusing on the management of soil and water for improved soil conditions and increased crop yield.

2. SOIL – WATER – PLANT – MAN RELATIONSHIP

Soil serves as a storehouse of water for human and plant use. Irrigation and rainwater become available to plants through the soil. Only a small part of the rain intercepted by the aerial parts is absorbed directly by plants. Plants grow on soils which provide them with water and nutrients. Thus, water as a carrier of a large amount of nutrients, is required in large measure for the successful growth of crops on soil. Soil is the reservoir that stores the water needed by plants to grow in order for man to eat as food.

Mr Vice–Chancellor Sir, distinguished audience, permit me to refer you again to a quotation from the Holy Bible when God instructed Prophet Ezekiel to speak a parable to the House of Israel. The book of Ezekiel, chapter 17, verse 8 says ***"….The vine was planted in a good soil by great waters that it might bring forth branches, and that it might bear fruit, that it might be a good vine" (NKJV)***. The vine as a **plant** was good for consumption by **man** because it was planted in good **soil** with great **water**. From this we can see that a close relationship exists between soil, water, plant and man.

2.1 Soil

Soil is a three-phase system consisting of solid, liquid and gases. The minerals and organic matters in soil together constitute the solid phase, while water forms the liquid phase and soil air, the gaseous phase. Of all the earth's crustal resources, the one we take most for granted is soil. As terrestrial animals, we depend on soil for life and yet most people think of it in negative terms.

Soil is an essential component of the biosphere, and it can be used sustainably, or even enhanced, under careful management. To understand the potential for feeding the world on a sustainable basis, we need to know how soil is formed, how it is being

lost, and what can be done to protect and rebuild good agricultural soil. An American writer and philosopher, Aldo Leopold was reported to have said, "***We abuse the land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect***". With careful husbandry, soil can be replenished and renewed.

2.2 Water

Water, one of the most common substances in the world, covers a substantial part of the Earth's surface. Water covers 71% of the Earth's surface and it is vital for all known forms of life. The question that has always been asked by policy makers in the area of water is, "Is water a resource or a commodity?" According to the first sentence of the Water Framework directives of European Communities in 2000, "***Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such***". Otherwise, it will not be adequate to meet the expected requirements.

Our study (Adekalu, K.O; **Osunbitan, J.A** and Ojo, O.E., 2002a) on water sources and demand in South west Nigeria affirmed that many people do not have access to piped water. Ogedengbe (1997) in his Inaugural lecture stated that the amount of water supplied per capita per day in the South west Nigeria is less than 25 litres. The rapid growth in population is not helping matters. Sangodoyin (1993) stated that the rapidly expanding population has resulted in the various water sources not fulfilling the requirement of consumption. The former United Nations (UN) Secretary General, Mr. Ban Ki-Moon at the World Economic Forum, in January 2008 also stated that "***Population growth will make the problem of water availability worse.*** According to him, ***"As the global economy grows, so will its thirst***".

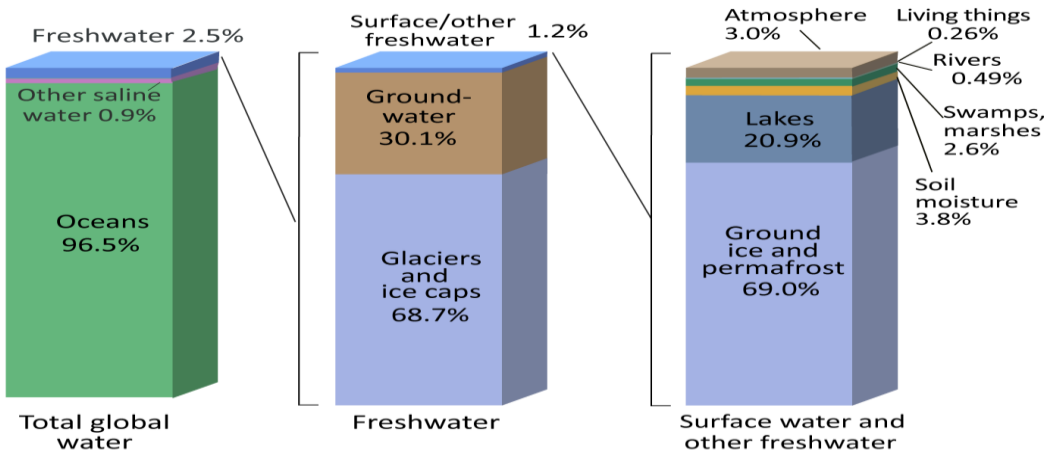

Figure 1: Global available water resources

Table 1: Per capita consumption of water/day

Continent/ Region	Africa	South America	Asia	Central America	Israel	Europe	USA	Australia/ New Zealand
Litre/day	70	183	226	231	240	337	556	601

Source: FAO Statistics (2008-2009) (www.worldwater.org

2.2.1. Categories of Water Use

The three major water usage categories are – water used in agriculture, water for industrial use and domestic water use. Globally, water used for agriculture accounts for 70% of the total usage. However, in developed countries, most of the water is used for industry. Agriculture accounts for 70% of global water use, while it is more than that in the developing countries (**Figure 2**). Moreover, in all regions of the world except the United States of America and Europe, agriculture accounts for more water usage (**Figure 3**).

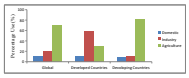

Figure 2: Major Categories of Water Usage

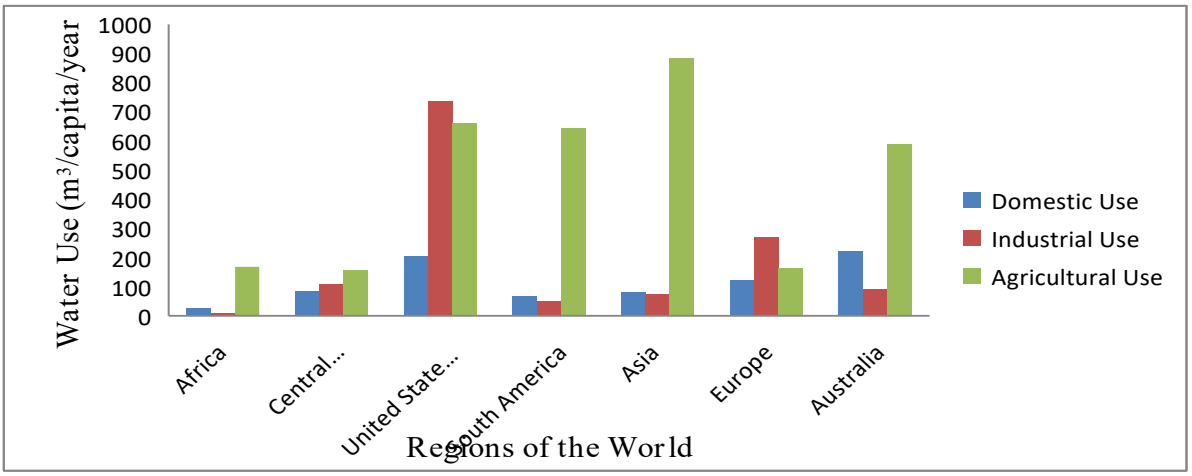

Figure 3: Regional Water consumption

2.2.2. Agricultural Water Use

Worldwide, crop irrigation is responsible for two-thirds of water withdrawal and 85% of consumption. Irrigation is the artificial application of water to soil for the purpose of crop production. Irrigation water is supplied to supplement the water available from rainfall and the contribution of soil moisture from groundwater. Conventionally, there are four different types of Irrigation based on water application methods: Surface Irrigation, Sub Surface Irrigation, Sprinkler Irrigation and Drip Irrigation.

Mr. Vice-Chancellor Sir, distinguished audience, it will interest you to know that the irrigation system and practice are as old as creation. According to the story of creation as recorded in the Bible,

> "***This is the story about the creation of the sky and the earth. This is what happened when the LORD God made the earth and the sky. This was before there were plants on the earth. Nothing was growing in the fields because the LORD God had not yet made it rain on the earth, and there was no one to care for the plants. So water came up from the earth and spread over the ground (Gen. 2:2-6, ERV)***".

Rain had not fallen, so the earth was watered from the ground upward, which is a type of irrigation that can be referred to as subsurface or capillary Irrigation. At another time in the history of creation, it was recorded that

> "***A river flowed from Eden and watered the garden. The river then separated and became four smaller rivers (Gen. 2:10, ERV)***".

Water from the river went out of Eden to water the garden planted by God, which is another type of irrigation that can be referred to as Surface or Gravity Irrigation. Sprinkler irrigation system was designed originally to simulate natural rainfall, whereby sprayed water falls on a plant like rain, while the drip irrigation system is a promising technology for reducing irrigation water use. Drip or Trickle Irrigation systems release a carefully regulated amount of water drop by drop through perforations or emitters just above plant roots, so that nearly all water is used by plants (James, 1988).

2.3 Plant

Plants grow on soils that provide them with water and nutrients. They absorb the water from soils mainly through roots and use only 1.0 to 1.5 percent of the volume of water absorbed for building their vegetative structures and performing various physiological and biochemical activities. The rest of the water absorbed is lost through transpiration. This close relationship between soil water and plant should be carefully understood in order to decide the time and depth of irrigation and to make efficient use of irrigation water. An excess or deficit of soil water hinders plant growth and thereby reduces the yield.

2.4 Relationship between Human and Plant

There is an ecological relationship between man and plants. Plants produce oxygen through photosynthesis, which is essential for human life, while man emits carbon dioxide, which plants use for photosynthesis. Plants are a primary source of food for man. Plants also provide shelter and habitat for man and other animals, through forests, grasslands, and other ecosystems. An ecosystem is a biophysical and socioeconomic environment that is defined by the interaction among climate, vegetation, biota and soil.

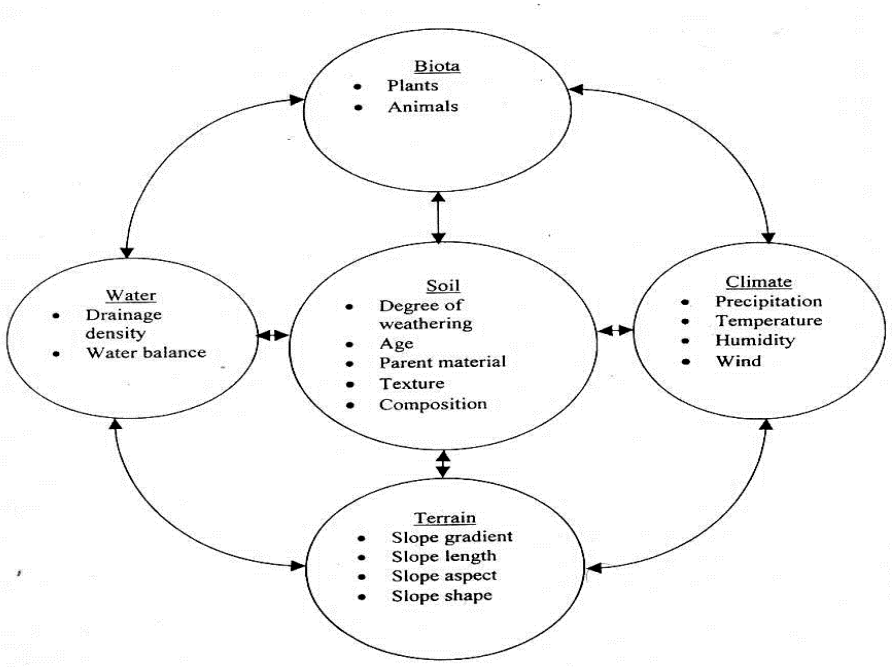

Figure 4: Soil as an integral component of an ecosystem (Lal, R and Shukla, M.K (2004))

In the ultimate analysis, there is an interdependent relationship between soil, water, plant and man. Plants require nutrient elements and water from the soil to grow, man relies on plants for food and plants rely on man for care and conservation.

2.5 Sustainability

Mr. Vice-Chancellor Sir, distinguished audience, the important questions that we should all ask ourselves is "Can the earth sustain our current lifestyles, and will there be adequate natural resources for future generations?" These are some of the most important questions in Environmental Science and Engineering today. We depend on nature for food, water, energy, oxygen, waste disposal and other life support services. Sustainability implies that we cannot turn our resources into waste faster than nature can recycle and replenish the supplies on which we depend. Although, we may be able to overspend nature's budget temporarily: future generations will have to pay the debts we leave behind. Living sustainably therefore, means meeting our own needs without compromising the ability of future generations to meet their own needs.

2.6 Agricultural Sustainability

The conservation of natural resources implies their utilization in a way that maintains high level of crop production while improving environmental quality. Sustainable agriculture therefore, involves sustained productivity as well as the protection of natural resources. The concept of soil quality is crucial for sustainable production.

What is soil quality?. Soil quality refers to the soil's capacity to perform its functions. It is the ability of soil to sustain the production of biomass in order to meet basic necessity of a growing human population. On the other hand, soil degradation is the decline in soil quality, making it unable to carry out some of its main functions. This leads to lower crop production and less ability to regulate the environment.

Thus, a degraded soil cannot perform specific functions of interest to plants and man. If the land is barren as a result of poor soil quality and the water in the same location, is bad, crops will not grow for man to eat. This was the situation of the children of Israel during the time of Prophet Elisha as recorded in the holy Bible, and I quote

"***The people of the city of Jericho told Elisha, This city's location is as good as you will ever find. But the water is bad, and the land cannot grow crops***" (***2 Kings 2:19; God's Word version***).

This is the condition of so many lands in this nation. The locations of many cities are good but their soil and water are bad, and as a result the land is unable to grow crops. There is therefore the need to make the soil and water environment conducive for plants and man if the soil is to continue to perform its numerous functions.

Mr. Vice-Chancellor Sir, distinguished guest, ladies and gentlemen, this has been the focus of my research activities over the last three decades since I joined the services of this University and the topic of my inaugural lecture which in a broader view is presented as "**Making Soil and Water Environment conducive for Plants and Man**".

3. MY CONTRIBUTIONS TO MAKING SOIL AND WATER ENVIRONMENT CONDUCIVE FOR PLANTS AND MAN.

3.1 Introduction

The focus of my research work is on soil and water management for improved soil conditions and ultimately increased crop yield. My earliest efforts, however, were directed at the computer-aided design of irrigation systems, where computer algorithms were developed to perform the design calculation for sprinkler irrigation systems.

3.2 Computer – Aided Irrigation Systems Design

The growing sophistication of computing machinery has not only made possible the rapid and accurate calculations of the complex parameters involved in irrigation system design, but it has also been a catalytic factor in the evolution of several mathematical theories and methods developed in the field of water resources in recent times (Fapohunda, 2002). A computer would carry out instructions and give accurate results only if it has been programmed to do so. I, under the supervision of Late Prof. H.O. Fapohunda took advantage of the existence of computers to make contributions in the design of irrigation systems using computers. Our contributions include cost comparisons of different sprinkler irrigation systems (**Osunbitan** and Fapohunda, 1998), the development of a computer algorithm for the solid set/set-move as well as center pivot sprinkler irrigation systems (**Osunbitan** and

Fapohunda, 2000a; **Osunbitan** and Fapohunda, 2001), modelling of pressure variation along the lateral of a center pivot irrigation system (**Osunbitan** and Fapohunda, 2000b) and the development of computer program for the design of vegetated waterways (**Osunbitan** *et al.,* 2009).

Economics is an extremely important consideration in pipeline design. Pipelines are normally designed to deliver water at the required pressure and flow rate throughout the irrigation system with minimum total costs. Pipe diameter and wall thickness, the amount of energy loss, and the size and type of pump are major factors affecting total cost. A good sprinkler irrigation system has an economical balance between pipe cost and power cost. The larger the pipe the more expensive it is. More pumping power, however, is needed to force water through small pipes because of increased water friction (Claude, 1970). Another factor to consider in the planning of sprinkler irrigation systems is the escalating cost of energy. An escalation factor can be used to evaluate the increasing cost of energy over the useful life of the system.

Mr. Vice Chancellor sir, we have been able to develop a computer algorithm that performed the calculations of the total annual cost of operating several pipe sizes of lateral pipe with the aim of determining the most economical pipe size for sprinkler irrigation system. The program takes into consideration the annual interest rate and energy cost escalation rate to select the most economical pipe size for a sprinkler irrigation system (**Osunbitan** and Fapohunda, 2002).

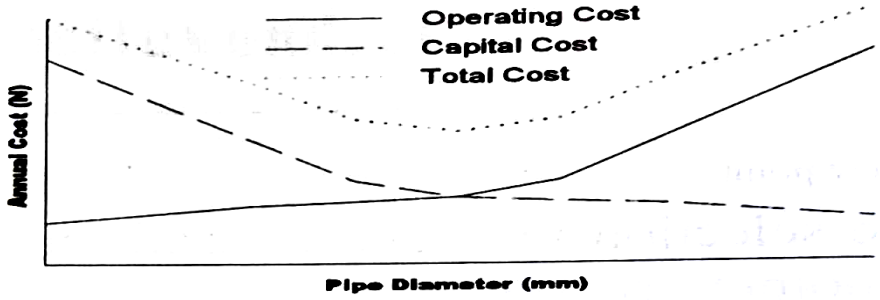

Figure 5: Typical relationship between pipe diameter and annual cost

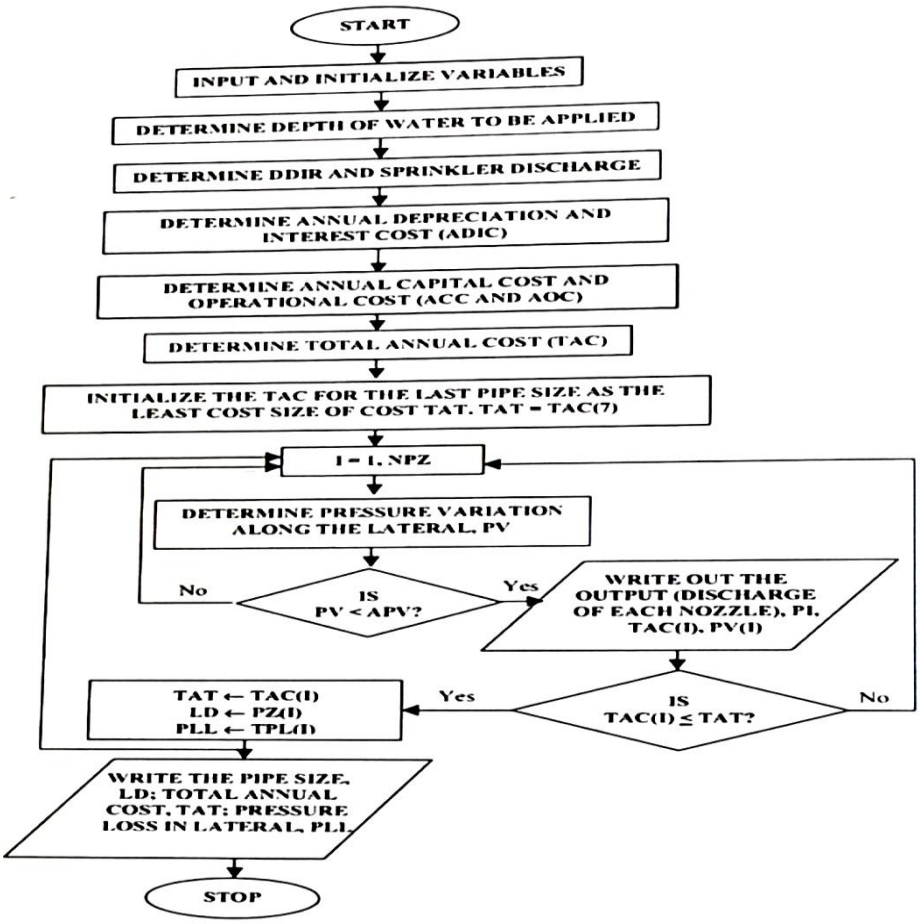

Figure 6: Flow chart for the most economic pipe size selection

3.3 Soil Properties as Influenced by Soil Amendments

Soil-plant-water relationships refer to how the properties of soil and plants affect the movement, retention and use of water by plant. Soil property is directly related to soil quality. Thus, soil quality is concerned with some measure of a property or function of soil.

Hydraulic Conductivity, Soil Porosity, Water Permeability and Moisture Retention

In a study carried out by Adekalu and **Osunbitan** (1995), the saturated hydraulic conductivity of five (5) different southwestern soil series increased with an increase in organic matter level. The optimum moisture content was found to be positively correlated with the sand content of the soils.

In other studies, on soil porosity and water permeability of two different south western Nigeria agricultural soils treated with poultry waste, cow dung and goat

dung, the soil porosity of the two soil types increased with an increase in percent organic waste incorporation. For the permeability, our study revealed that there was an appreciable decrease in permeability with an increase in organic waste addition to the soil.

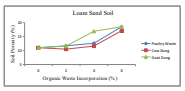

Figure 7: Organic Waste effects on Soil Porosity of Sandy loam and Loamy sand soils

Table 2: Permeability of Loamy Sand soil as influenced by Organic Wastes and Incubation Period

Organic Waste type	Incubation Period (Days)	Permeability (mm/sec)			
		Percent Organic Waste Incorporation (%)			
		0	2	4	6
Poultry Waste	7	0.0076	0.0079	0.0075	0.0073
	14	0.0076	0.0067	0.0058	0.0055
	21	0.0076	0.0056	0.0057	0.0050
Cow Dung	7	0.0076	0.0083	0.0085	0.0090
	14	0.0076	0.0027	0.0110	0.0100

	21	0.0076	0.0100	0.0090	0.0082
Goat Dung	7	0.0076	0.0061	0.0061	0.0064
	14	0.0076	0.0063	0.0061	0.0062
	21	0.0076	0.0056	0.0057	0.0059

Mulching Effects on Infiltration, Runoff, Sediment yields and Soil loss

The need to reduce surface runoff and soil loss on agricultural soils and increase crop productivity has led to the use of crop residue as mulching on agricultural fields. The process of erosion and sediment transport by rainwater is selective in terms of particle size and weight. Generally, the coarser sediments deposit first and the finer ones move further. As a result, suspended sediments usually have more fine and less dense particles. Because these fine particles usually contain higher amounts of adsorbed chemicals, it follows that eroded sediment fractions and its relationship with the original soil mass could be used to explain the risk of surface water pollution.

Soil Crust Strength and Soil Compaction

One of the most essential factors for seedling germination and emergence and crop growth in general is soil moisture. Seedlings obtain moisture through the soil from precipitation and irrigation. However, these could produce crust that may retard or prevent emergence if the water is not applied with the suitable intensity and duration. Soil crust results from the breaking down of soil aggregates, movement of fine particles into the upper few centimetres and compaction of the soil surface to form a thin film which restricts further entry of water. In one of our studies, we obtained linear (Equation 1) and multiple (Equation 2) regression equations relating crust strength to rainfall duration and intensity (Adekalu and **Osunbitan**, 2000). The strength of the crust increased with increasing rainfall intensity and duration before it starts to decrease at very high intensities and durations.

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($R^2 = 0.78$, N =512)

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(R^2 = 0.71, N =512)

where,
C = Crust Strength (N); DR = Rainfall duration (minutes); T = Rainfall Intensity (mm/hr)

It was concluded from the study that since weak crusts favour seedling emergence, water should be applied at low intensities for short durations as pre-emergence irrigation or planting should be delayed till rainfall is of shorter duration and low intensities. The crust formed at high intensities and duration is not desirable as surface ponding sets in resulting in runoff and consequent erosion of the top soil under field conditions.

Compaction of agricultural fields results mainly from rainfall or irrigation and farm traffic, with the effect of farm traffic being more severe. Adekalu and **Osunbitan** (1995) reported that the maximum dry density obtained by compaction decreased with increasing level of organic waste confirming the earlier report by Ohu *et al*., (1991). Maximum dry density and optimum moisture content levels for some soil series in south western Nigeria with different levels of organic matter and compaction levels were related to the sand and silt content.

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(R^2 = 0.80, N =144)

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(R^2 = 0.85, N =144)

where B_d = Maximum dry density (g/cm^3); S_d = Sand content; G = Organic matter level; C = Compaction level; M_c = Optimum moisture content; S_t = Silt content

Mr. Vice-Chancellor Sir, in Nigeria, the cost of farm machinery operation has been a major concern in the past. Apart from the high initial cost of farm tractors, the high fuel cost has now led to a substantial increase in operational cost of agricultural mechanization. The draft force required by a tractor in pulling equipment through the soil is a function of the shear strength of the soil. The higher the draft force, the higher the fuel consumption of the tractor. The dry density of soil at traffic increases with moisture content up to a maximum value at a predetermined critical moisture content which is below the liquid limit of the soil, and thereafter decreases with moisture content (Ohu *et al.,* 1987; Adekalu and **Osunbitan**, 2001).

Thus, farm operations are better performed below the critical moisture content, when the soil is relatively dry. If the moisture content of a soil is low, individual soil particles cannot come close to one another, and there will be air voids. On the other hand, if the moisture content is high, there will be a greater flow of particles when pressure is applied, but these particles will be separated by a film of moisture. When the soil dries, the films of water disappear, leaving behind air spaces. Thus, too low moisture content and too high moisture content are undesirable (Adekalu and **Osunbitan**, 2001)

Our study (Adekalu, K.O; Okunade, D.A and **Osunbitan, J.A**., 2007b) investigated the effect of applying different compactive efforts at varying moisture contents on the physical and strength characteristics of three prominent agricultural soils in south-western Nigeria. It was noted from the study that the higher compaction level increased the dry density and shear strength of the soil while shear strength decreased with increasing moisture content of the soils for all compaction levels. From our findings, we derived a multiple regression equation relating the significant components.

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where MC – the equilibrium moisture content (%);*Error! Reference source not found.* ***the dry density (g/cm^3); ****Error! Reference source not found.* ***the clay content (%) and OM – the organic matter content (%).***

Tillage Effects on Soil Properties

Reduction of labour requirements has been the principal motivating force for agricultural mechanization. The application of machines to agricultural production has been one of the outstanding developments in developed countries. However, tillage operation does not have to be with heavy-duty machines like tractors. Depending on soil type and availability of agro-chemicals, zero tillage or minimum tillage can give better results. Tillage operation is as old as mankind. Genesis chapter 2 verse 15 says,

> "***And Jehovah Elohim took Man, and put him into the garden of Eden, to till it and to guard it (Darby version)***".

The primary assignment given by God to the first man he created, according to the Holy Bible is to till the ground i.e. to perform tillage operations. I therefore

congratulate as many of us who are involved in the work of tillage because we are doing the primary assignment given to man by God.

Our study (**Osunbitan** *et al.,* 2005a) on tillage effects on some soil properties asserted that soil bulk density and the penetration resistance of loamy sand soil decreased with an increase in the intensity of soil loosening by tillage operation. Both soil bulk density and penetration resistance increased with an increase in length of time after tillage operation. Soil saturated hydraulic conductivity decreased with the degree of soil manipulation during tillage operation.

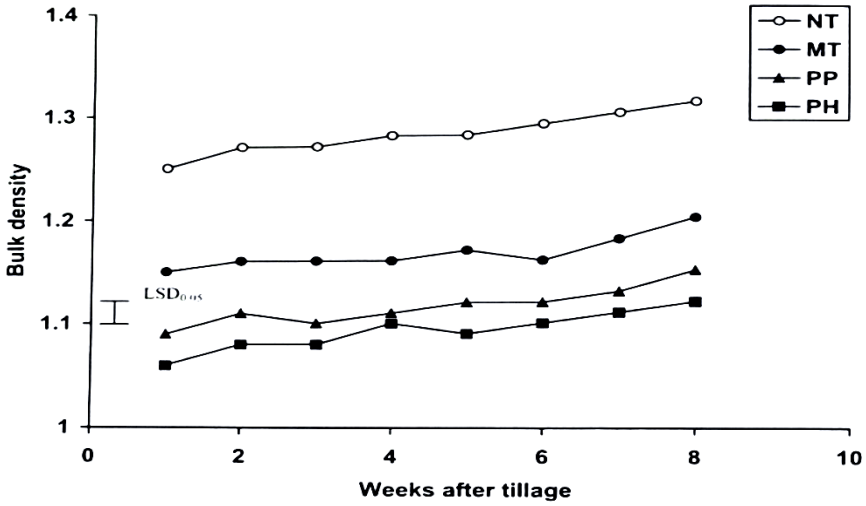

Figure 8: Mean bulk density (mg/m^3) of surface (0-5cm) soil under different tillage systems at different times after tillage

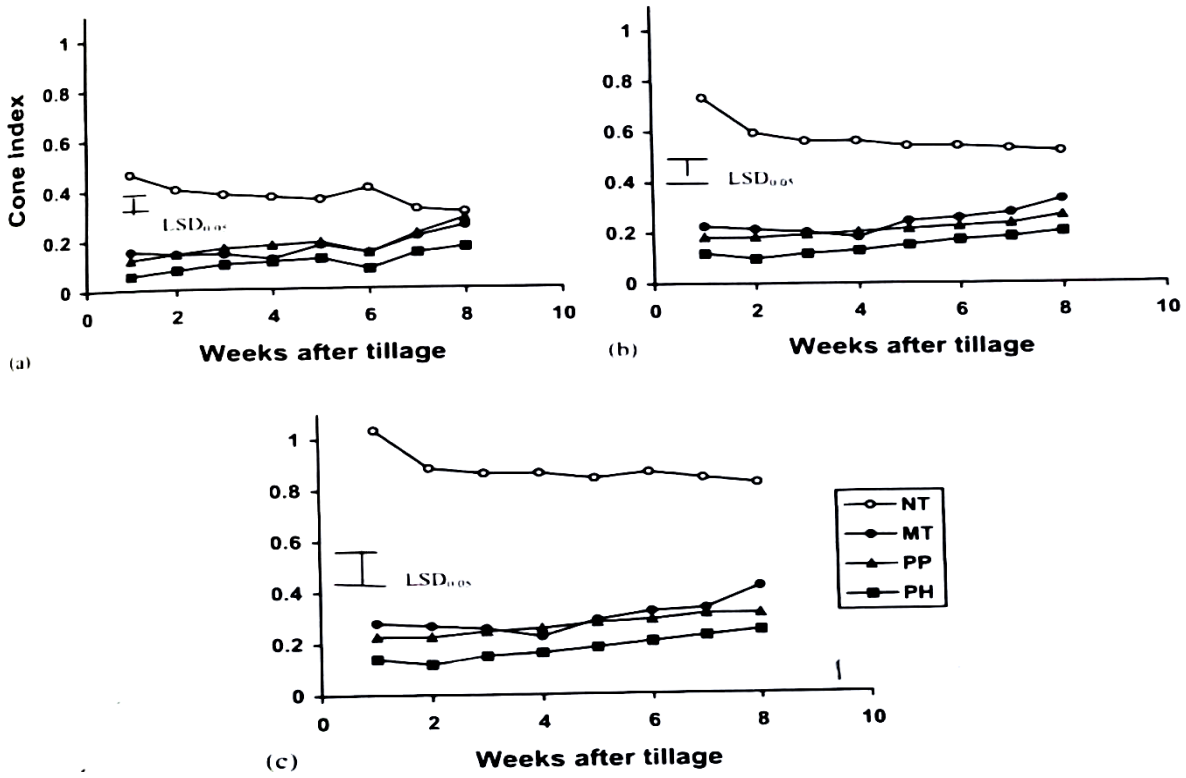

Figure 9: Soil cone penetration resistance (kg/cm^2) at depths of (a) 0-5 cm, (b) 5-10 cm and (c) 10-15cm in response to different tillage methods

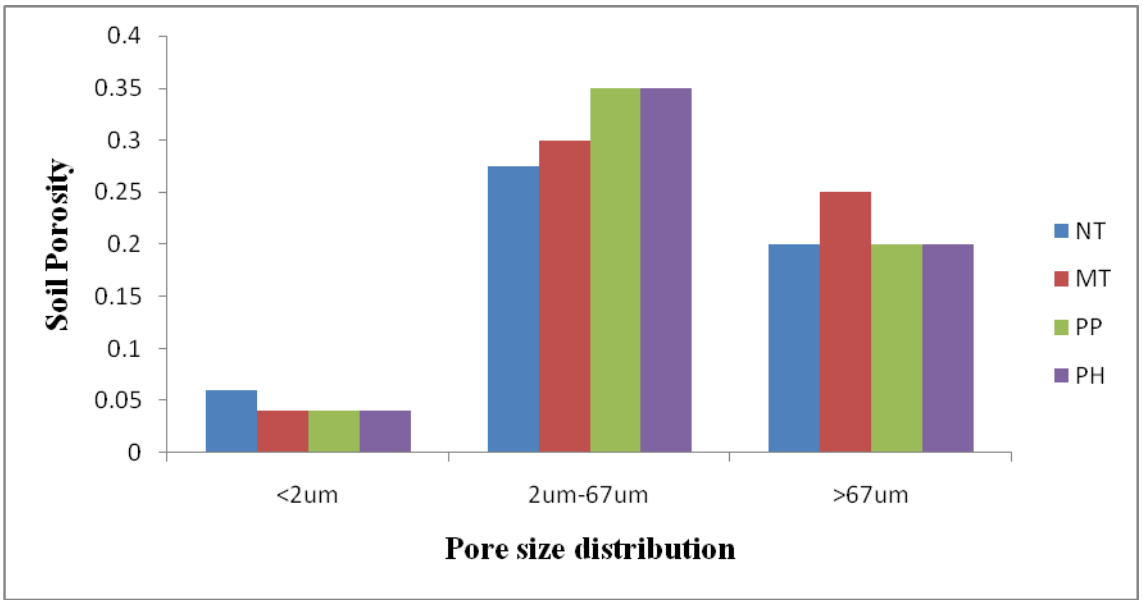

Figure 10: Soil pore size distribution at 8 weeks after tillage as affected by treatments

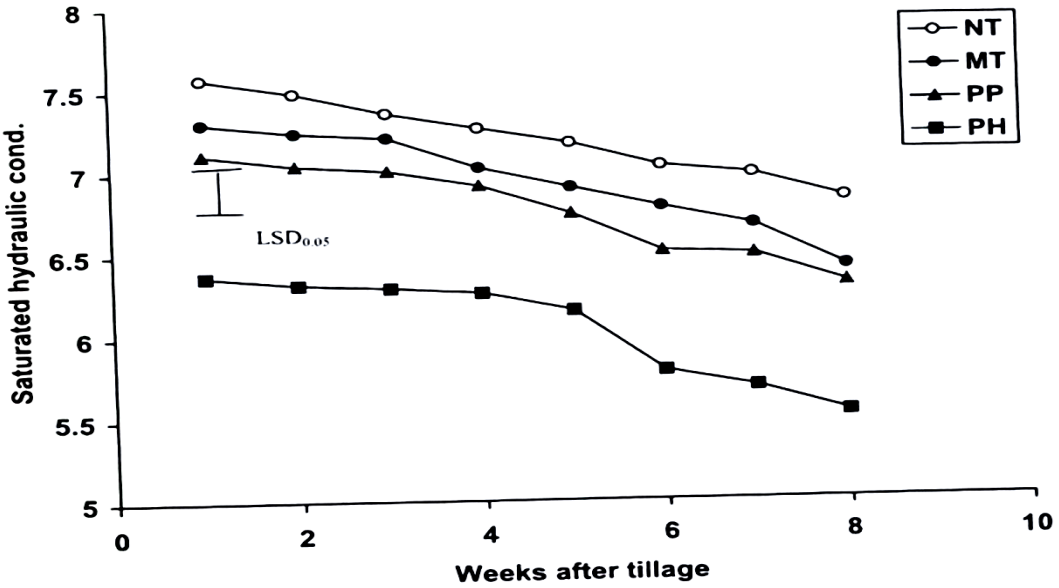

Figure 11: Mean saturated hydraulic conductivity (x 10^{-3} cm/s) of the surface (0-15 cm) soil under different tillage systems at weeks after tillage

3.4 Crop yield as affected by Soil Tillage and Other treatments

Achieving optimum crop yield has always been a challenge for the farmer due to ever-changing environmental conditions. The factors that influence crop yield include soil condition, water availability in the soil and the quality of seed planted. Tillage operation is one of the soil management factors that can affect water storage properties of soil and thereby influence crop yield.

In our study (Adekalu, **Osunbitan,** and Okunade, 2002), we examined the growth and yield response of cowpea to tillage and irrigation water deficit using a line source sprinkler system. It was observed from the study that minimum tillage produced greater cowpea yield than conventional tillage with the difference becoming more pronounced with decreasing water application. It was also noted from the study that conventional tillage produced greater root development in cowpea than minimum tillage; hence it will be better suited for root crops especially when there is high rainfall as conventional tillage also provides good drainage (Adekalu, **Osunbitan,** and Okunade, 2002b).

In other studies (**Osunbitan** and Adekalu, 2012; **Osunbitan**, 2013), we analyzed the effect of poultry waste incorporation into the soil on the yield and water use efficiency of Jute Mallow (known as *ewedu* in Yoruba land). The study developed a relationship between the dry matter yields of the vegetable and the organic waste

addition to the soil. It was noted from the study that both the dry matter yield and water use efficiency of the vegetable first increased to the maximum with increasing poultry waste incorporation from 0% to 2% before decreasing. The relationship between the dry matter yield and the organic waste incorporation is a polynomial of the third order.

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where DMY – Dry Matter yield (kg/ha); W – Organic Waste (%)

Using this relationship, the optimum level of poultry manure for the highest dry matter yield is exactly 2.24%, which translates to 18 t/ha. We therefore concluded that Jute Mallow requires a relatively low irrigation interval and poultry manure for a good yield.

3.5 Surface and Groundwater for Small-Scale Irrigation.

Mr Vice Chancellor Sir, knowing that Irrigation water can be obtained from two sources, our study (Osunbitan *et al*., 2005b; Oyewusi, **Osunbitan** and Adekola, 2021a) evaluated the quantity and quality of groundwater for Irrigation in the basement complex of Ile-Ife, Nigeria and found that the groundwater yield in this area can be as much as 100 m^3/day. An examination of the groundwater parameters and the crop water requirements from our study indicates that the supply could meet the demand, at least on a small-scale irrigation project in the area underlain by the basement complex. It was also observed that most of the sampled groundwater in this area is within the low electrical Conductivity (EC) limit.

3.6 Agricultural Chemicals and Wastes in the Environment

Faborode (2005) while justifying the repositioning of Agricultural Engineering profession and the need to change the name of the department to Agricultural and Environmental Engineering stated that the interaction between soil, water and the atmosphere, which induces numerous effects on the human and plant environment, are within the scope of the discipline of Agricultural Engineering.

One of the sources of soil contamination is Agriculture. Soils that are in agricultural use have been affected by different treatments either deliberately or in-deliberately. Some treatments, such as organic or inorganic fertilizers and agro-chemicals are added deliberately. Fertilizers are added to improve the capacity of

the soil to provide nutrient elements for crops, while pesticides are used to control pests and diseases. However, the use of chemicals in agricultural watersheds has been recognized as a potential source of environmental pollution especially with respect to soil and water quality.

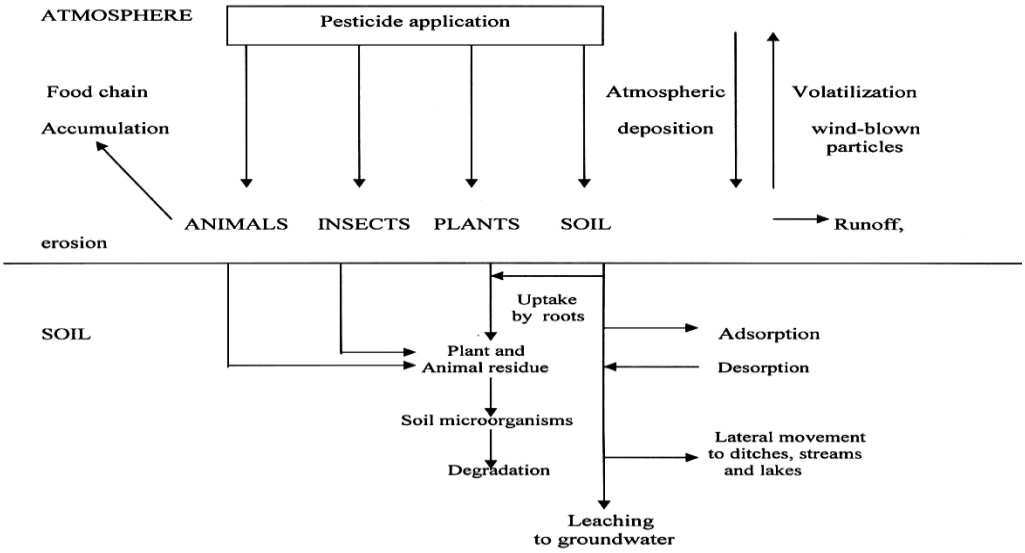


Figure 12: The pathway and reactions of Pesticides in the soil

Mr. Vice-Chancellor Sir, in the area of Agricultural and Ago-Environmental Engineering, our work (My PhD Supervisors, Prof. P.O. Aina, Prof. K.O. Adekalu & I) has contributed to the fundamental knowledge on the adsorption of heavy metals from fungicides to soil particles as well as their mobility within the soil environment. To the glory of God, my PhD thesis supervised by these erudite Professors was adjudged by the National Universities Commission (NUC) as the best PhD thesis in the discipline of Engineering/Technology within the Nigerian University system in 2007.

Cassava Wastewater in the Environment

Effluents from cassava processing factories have been known to have very strong strength and potent ability to pollute both land and water bodies. Cassava processing effluents are a mixture of liquid waste as well as other wash water used in the industry. Part of the effluent from the processing of this tuber crop infiltrates into the soil while the remaining part that is left on the soil surface is easily washed away by runoff into nearby stream.

Plate 1: Example of pollution of land and water bodies in a cassava processing factory

3.7 Agricultural Waste and Wastewater Treatment and Reuse

In every aspect of human life unwanted materials are generated and then discarded simply because they are considered to be wastes. However, there are different ways of dealing with wastes, starting with the most beneficial and working down to 'disposal', which is the worst way of getting rid of waste. Different options of dealing with waste are **Reduction**, **Reuse, Recycling, Recovery** and **Disposal.** Disposal is about finding a place to get rid of wastes that cannot be treated by any of the other alternatives.

Reduction is the process of producing less waste. Reuse is using a waste product without further transformation and without changing its shape or original nature. Recycling is when the waste material is reprocessed before being used to make new products. Recycling is treating the materials as valuable resources rather than as waste. A renowned Biologist who helped to initiate the modern environmental movement, Barry Commoner reportedly said, "***Everything is connected to everything else, and everything must go somewhere***".

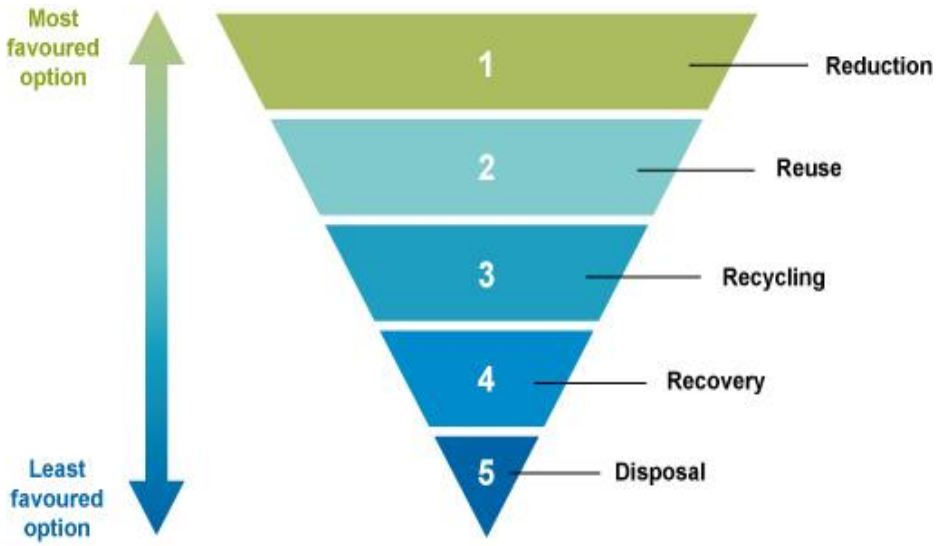


Figure 13: Different way of dealing with Waste

Mr. Vice-Chancellor Sir, in the area of Waste and Wastewater treatment and reuse, our work (My PhD students, now Dr Toyese Oyewusi and Dr. Olayinka Omotosho & I) has contributed to the fundamental knowledge of waste/wastewater treatment and reuse. In order to protect adjacent land and water bodies around cassava processing industries from pollution by cassava wastewater, a laboratory-scale treatment setup for treatment of wastewater from a cassava processing factory was established, and pilot scale plant for on-site cassava processing effluent treatment was designed.

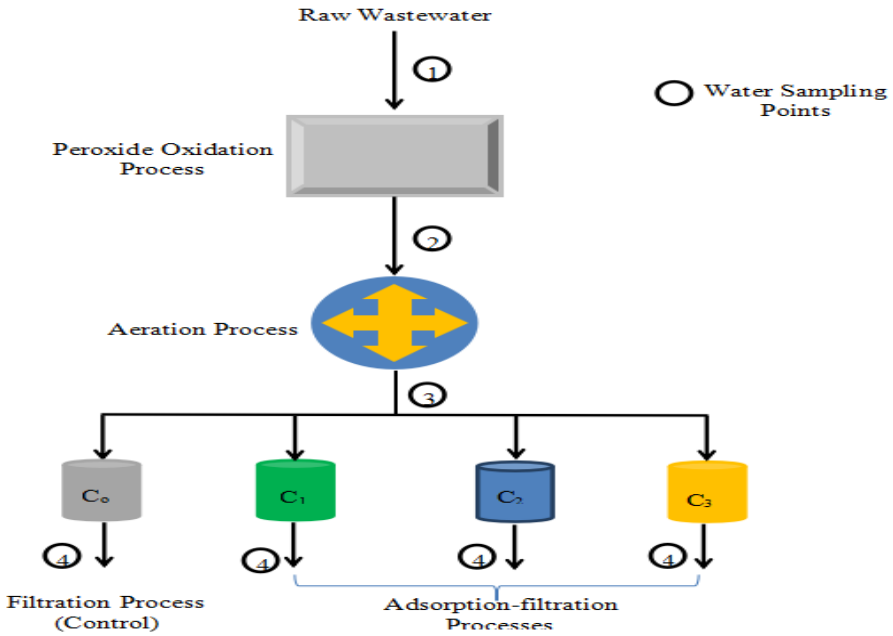
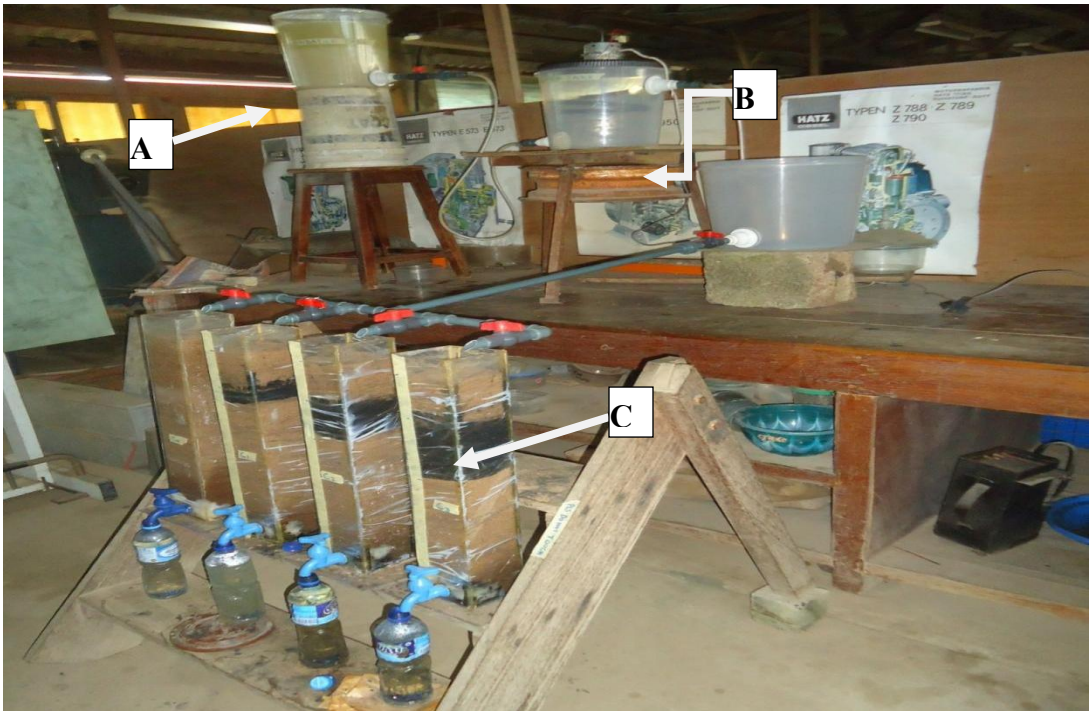


Figure 14: Schematic diagram of treatment process



A=Aeration Stage B=Oxidation Stage C=Filtration/Adsorption stage

Plate 2: Setup of laboratory scale treatment procedure

O=Raw Wastewater, **A**=Oxidized Wastewater, **B**=Aerated Wastewater, C_o= Control; C_1= 5 cm carbon depth treatment; C_2= 10 cm carbon depth treatment; C_3= 15 cm carbon depth treatment

Plate 3: Physical appearance of water samples drawn along the treatment line

We investigated the effects of using the treated wastewater for irrigation on the growth and yield of vegetables. The results revealed that the treated wastewater can be safely reused in the cultivation at vegetables at a concentration not greater than 50%.

Plate 4: Vegetables irrigated with the treated cassava wastewater ten days after planting.

Farming activities in a country where 60% - 70% of the population is involved in agricultural related activities will result in the production of various economic products from which many types of residues that are biomass materials containing an enormous amount of energy are left as waste materials after harvest. Presently, agro-waste management practice in the country is that of burning or allowing them to decay on the farm. Any of these two approaches causes environmental contamination and pollution, aside from also resulting to enormous waste of resources. Burning of agricultural wastes on a farmland affects soil biodiversity, geomorphic processes and volatilizes a large amount of nutrients in the soil including organic matter, while black carbon and particulate matter emitted into the atmosphere during the process is also worrisome. A theoretical physicist, Albert Einstein said, "***The complex problem we face today will not be solved by the same level of thinking that created the problem***". Therefore, there is a need to change our approach in handling agricultural solid wastes if the soil environment is to be conducive for plant and man.

Compost Extract for Fertigation

Composting is one of the most common waste management technologies in converting biodegradable agricultural wastes. It is the breakdown of organic

compounds in biodegradable wastes into nutrients in the presence of oxygen, water and microorganisms. Application of compost to soil in place of fresh manure has some advantages but may also have some disadvantages. Some of the disadvantages include: slow discharge of nutrients into the soil and environmental contamination that results from high application rates due to low nitrogen concentration of the compost.

Compost extract is a soluble form of compost, which can be prepared in different ways using compost as an initial substrate. It is the water extraction of soaked compost that contains soluble nutrients. Application of compost extract can be done through a fertigation system since it gives the opportunity to derive adequate nutritional values of compost application. Fertigation is a system, whereby fertilizers are incorporated into irrigation water to be applied to plants to achieve better efficiency of fertilizer use resulting in high crop yields.

Our studies (Oyewusi, 2021; Oyewusi and Osunbitan, 2021; Oyewusi, **Osunbitan &** others, 2021c and Oyewusi, **Osunbitan,** & others, 2023) extracted the nutrients from composted chicken manure and applied it as liquid organic fertilizer. We also investigated the effect of processing parameters for compost nutrient extraction on the growth and yield parameters of two vegetables and examined the effects of the compost extract application on some soil physical and chemical properties after harvest.

Plate 5: The set-up of the improvised "drip fertigation" system for vegetable production

4. Other Contributions

Mr. Vice-Chancellor Sir, Ladies and Gentlemen, the three major activities of an academic are Teaching, Research and Community Service. I have spent the last three decades of my life doing all these three activities.

My contribution is not limited to research alone. I have made significant contributions in the area of teaching, capacity building and mentoring of students and staff at the Department, Faculty and University levels. I teach both undergraduate and postgraduate students in the Agric. and Environmental Engineering Department of this University. As Visiting Professor or Adjunct Lecturer, I have also contributed to training students (both at Undergraduate and postgraduate levels) at Covenant University, Ota and Joseph Ayo Babalola University, Ikeji Arakeji. Many of these former students are now established in their chosen careers. I have supervised and am still supervising both Masters and PhD students.

Consultancy Services and Capacity Building

In my early days as a Graduate Assistant, Prof. Obafemi Ajibola (former Deputy Vice-Chancellor (Admin) and retired Prof. of Agricultural Engineering) introduced me to consultancy services. I was one of the resource persons for TECHNOSERVE that surveyed Fabricators and Processors of Agricultural Implements in Nigeria. I also participated as a resource person under his supervision for the National Agricultural Land Development Agency (NALDA) on the Formulation of soil conservation plan and Design of conservation structures for the NALDA project in Igboye-Iju , Epe Local Government Area, Lagos State.

I was included among the team that carried out survey sponsored by UNDP on the "Capacity and Agro-Technology needs of women in Osun and Ondo States" as well as the assessment of Agro-Processing Centres in Osun State in spite of my area of specialization. I also participated as a resource person for New Nigeria Foundation (NNF) on the OFADA Rice Baseline study in Ogun, Lagos, Osun and Ekiti states of Nigeria. Some of the general information obtained on the field is not only submitted as a Technical report but also published in reputable journals (Ajibola, Aluko, **Osunbitan** and, 1996; **Osunbitan** *et al.,* 2000; Taiwo, **Osunbitan** & others, 2001).

With the exit of Prof. O.O. Ajibola from the University, Professor M.O. Faborode (Former Vice-Chancellor) took over the leadership position of the Post Harvest research group founded by Prof. O.O. Ajibola. The scope of the group was enlarged to include socio-economists, policy analysts and water resource engineers. With the International partners from the University of Newcastle and support from the British Fund for International Cooperation in Higher Education of the Department for International Development (DFID), the group embarked on Rainwater Harvesting Research activities with the aim of "assessing the needs and uptake promotion of rainwater harvesting research in Nigeria". The study on Rainwater Harvesting which I was actively involved in produced two (2) PhD graduates; one of them is already a Professor and current Head of Agric & Environmental Engineering.

By the grace of God, I have had opportunities to travel out of the country for various academic activities. I was at the University of Newcastle, United Kingdom for an exchange programme; at another time on DFID Rainwater Harvesting Programme; I was in Israel at the Hebrew University of Jerusalem on Israeli MASHAV Scholarship; At Minia University, El-Minia, Egypt for International Conference; At Munich, Germany for Practical International Workshop on Lysimeter and Sap Flow.

Services within and outside the University

Administratively, I have had the opportunity of holding some positions of responsibility in the University. I was the Vice Dean of Faculty of Technology (2008-2011), Head, Department of Agricultural and Environmental Engineering (2017-2020), Member and later the Chairman, Campus Aesthetic and Trading Regulatory Committee, CATREC (2016-2018 and 2018-2019, respectively), Member and later the Chairman, Anti Corruption and Transparency Unit, OAU (ACTU) (2018-2023 and 2024-Date, respectively), Member, University Board of Survey (2020-Date). I am presently the African Centre of Excellence Environmental and Social (E&S) Safeguard Officer for OAU ICT-Driven Knowledge Park. I have also served in various other committees at the departmental, faculty and university levels.

I have served as an Internal Examiner to some departments in the University and External Examiner to some Institutions in the country. The institutions include: University of Agriculture, Abeokuta, University of Ibadan, Covenant University, Ota, and Federal University of Technology, Akure.

To the glory of God, I have also assisted in assessing colleagues within the University and in several other Institutions in the country to the rank of Professor or Reader. These include colleagues in Faculty of Science, Faculty of Environmental Design and Management, my own Faculty (Technology), University of Maiduguri, University of Nigeria, Nsukka (UNN), Ladoke Akintola University of Technology (LAUTECH), Ogbomosho, Ekiti State University (EKSU), and Ambrose Alli University, Ekpoma.

I have contributed my quota to the development of education in the country. I have been a member of several NUC Accreditation Teams for the accreditation of programmes related to my field in some federal and state Universities in the country. I was the coordinator of all the Redeemed Christian Church of God schools (Primary and Secondary) in Osun state for seven years. Presently the coordinator of the schools in Ife and Ijesha lands. By the grace of God, I have been the Chairman, Board of Governors of the Redeemer International Academy, Ifewara, for the past six years.

5. Concluding Remarks

Mr. Vice Chancellor Sir, I have tried in this lecture to present some of the activities that have engaged my research time in this university. I have shown in this lecture that creating a conducive soil and water environment for plant and man is key to agricultural sustainability and the promotion of environmental health. The capacity of soil to provide nutrient elements for crops or vegetables as well as the capacity to store water, can be greatly enhanced with some of the soil amendments presented in this lecture.

We should all remember that the soil beneath our feet, the groundwater and the water that flows around us are not mere resources, but sacred trusts handed down through generations. Their health reflects our stewardship, and their degradation echoes our neglect. The future of Agriculture, food security, and indeed human survival depend on what we sow today into our soil and how we care for every drop of water

From this lecture, one truth stands clear – our survival and prosperity are deeply rooted in the health of our soil and water. I urge us all to recognize the intricate relationships between soil, water, plants, and man. The health of our planet depends on our ability to manage these vital resources sustainably. These natural resources are

not infinite; they require careful management, scientific innovation, and a commitment to sustainability. If we nurture the soil, it will nourish us. If we protect our water, it will sustain us. But if we neglect them, we jeopardize not just our present, but the future of generations to come

Let us all leave here as advocates of a greener tomorrow, champions of soil integrity, and guardians of our watersheds. Together, we can make our environment not just livable, but flourishing for all forms of life. As we strive to make the soil and water environment conducive for plants and man, let us all remember that this is a collective responsibility. It requires the collaboration of policymakers, researchers, farmers, and communities.

Together, we can:

1. Promote sustainable agriculture practices that prioritize soil health and efficient water use
2. Develop and implement policies that support environmentally friendly land-use management
3. Advance research and development of innovative technologies that enhance soil fertility and water conservation
4. Educate and empower communities to adopt best practices in soil and water management

6. Appreciation and Acknowledgement

Mr. Vice-Chancellor Sir, permit me to use this opportunity to appreciate all those, too numerous to mention, who God, by divine providence, have used to contribute to my success story in life.

Foremost, I am grateful to the Almighty, only wise God, the Alpha and Omega, the Giver of life and wisdom. I am grateful to God the son, Jesus who is the word of God and the greatest teacher. I am grateful to the Holy Spirit, the breath of God in me.

Prof. H.O. Fapohunda (of blessed memory), supervised my M.Sc thesis and exposed me to what is called “Computer and Electronics in Agriculture”.

Prof. O.O. Ajibola introduced me to Consultancy and made his shoulder wide enough for me to stand on in order to see far in academics.

Prof. M.O. Faborode took special interest in mentoring me, especially when I lost my PhD supervisor at the beginning of the Programme. He facilitated the linkage between me and Prof. P.O. Aina

Prof. P.O Aina (former Vice-Chancellor, Ekiti State University and retired Professor of Soil Science) or who "adopted me as his Academic son" when my then Ph.D. supervisor died. I am grateful, sir.

Prof. K.O. Adekalu, the leader of the Soil and Water Engineering Research group in the Department. Sir, you showed me what conducting research is all about and how to write journal articles early enough in my academic journey. This can easily be seen in my earlier publications. *Oga*, as I fondly call you, I am eternally grateful, sir.

Emeritus (Prof.) M.O. Makanjuola and Emeritus (Prof.) Fola Lasisi for their fatherly role in the Department, Prof. M.T. Ige (Rtd) and Prof. O.A. Ajayi (Rtd), Prof. L.O Adekoya (Rtd), I am grateful, sir.

I am grateful to the Dean (present and past) of Faculty of Technology. I am particularly grateful to Prof. T. Kuku, Prof. K.A. Taiwo for their leadership role and also Prof. G.A. Aderounmu for the opportunity to serve at the African Centre of Excellence. All Academic and Non Academic Staff of Agric. & Environmental Engineering Department, I appreciate you all. All my research partners, Prof. D.J. Oyedele, Prof. D.A. Okunade, Dr. O.B. Adeboye, other lecturers and people that have contributed one way or the other towards my academic and professional success, you are all highly appreciated. To all my students (in the past and presently), I say a big thank you.

I am grateful to all members of the planning committee. We had barely one month to plan and you put in all your efforts for today's outing to be successful. Your labour of love will never go unrewarded in Jesus' name.

The Church, RCCG

Mr Vice chancellor sir, permit me to recognize some of the people among many others that the Almighty God brought across my path in life for the spiritual aspect of my life to be attended to. Pastor & Pastor (Mrs) E.A. Adeboye (the General Overseer of RCCG), all my spiritual leaders at the National, Continental and Regional levels. I specially appreciate Pastor & Pastor (Mrs) Paul Adegboyega Awede, Pastor & Pastor

(Mrs) Joel Emeka Ezebudey, Pastor & Mrs Johnson Adediran and Pastor & Pastor (Mrs) Ayo Ajisola for their interest in my spiritual growth. I appreciate all members of the Redeemed Christian Church of God, thank you all for your love and prayers.

Parents and family

To my parents Chief Elijah Akintolu Osunbitan (of blessed memory) and Madam Emily Osunbitan (Nee Ogunnubi) for laying the foundation of my education at an early age, I am eternally grateful. I thank the Almighty God for preserving the life of my mother to witness this day; ***Mama, mo dupo o; ema jehun omo pe loruko Jesu***. I also thank all my siblings; Mrs Yemisi Olusanya, Mr & Mrs Gbenga Osunbitan, Mr. & Mrs Kayode Osunbitan, Pastor & Mrs Bisi Oluwatola, Mr & Mrs Funke Afolabi, Mr. & Mrs. Omololu Osunbitan & Dr & Mrs Bunmi Ojo for their roles at different times in my life. I also put on record the contribution of my uncle Alhaji Ishola Ogunnubi at the early stage of my post-secondary school education. I thank all my in-laws for their support and understanding.

Finally, I wish to express my heartfelt appreciation to our children – Oluwanifemi, IyanuOluwa, and Oluwabusayomi for their understanding during the course of my academic pursuit. To my darling and beloved wife, Pastor (Mrs) Lydia Adenike Osunbitan, whom we have been together for close to 30 years through thick and thin. I appreciate your patience, love and sacrifices.

The Almighty God

And unto the one who alone does great and wondrous things, the Alpha and the Omega, the only wise God; be glory, honour, power and majesty Amen.

Alpha, my beginning; Omega, my very end
You are worthy to be praised, only you, only you

Mr Vice Chancellor Sir, distinguished audience, thank you all for coming and for your attention.

REFERENCES

Adekalu, K.O and **Osunbitan, J.A.** (1995). The Influence of Goat Dung on the Compactibility and Hydraulic Properties of Some Soils in Southwestern Nigeria. *Journal of Agric. Engineering and Technology,* 3, 97 - 105.

Adekalu, K.O and **Osunbitan, J.A** (2000). Effect of Irrigation Intensity and Duration on Soil crust Strength. *Ife Journal of Technology*, 9 (1), 21 - 25.

Adekalu, K.O and **Osunbitan,J.A** (2001). Compactibility of some Agricultural Soils in Southwestern Nigeria. *Soil and Tillage Research* , 59 (1), 27 – 31

Adekalu, K.O; **Osunbitan, J.A** and Ojo, O.E. (2002a). Water Sources and Demand in Southwestern Nigeria: Implication for Water Development Planner and Scientists. *Technovation* 22 (12): 799 – 805.

Adekalu, K.O; **Osunbitan, J.A** and Okunade, D.A.(2002b). Effect of Water application rate and tillage on the growth and yield of cowpea. *Agric. Mech. in Asia, Africa and Latin America,* 33 (1), 20 – 24

Adekalu, K.O; Okunade, D.A and **Osunbitan, J.A** (2006). Compaction and mulching effects on soil loss and runoff from two agricultural soils in southern western Nigeria. *Geoderma 137, 226 - 230.*

Adekalu, K.O; Olorunfemi, I.A. and **Osunbitan, J.A** (2007a). Grass Mulching on Infiltration, Runoff and Soil Loss of three agricultural Soils in Nigeria. *Bioresource Technology, vol 98, 912 - 917.*

Adekalu, K.O; Okunade, D.A and **Osunbitan,J.A** (2007b). Estimating trafficability of three Nigerian agricultural soils from shear strength-density-moisture relation. *International Agrophysics, vol 21, 1 - 5.*

Ajibola,O.O; Aluko, O.B; **Osunbitan, J.A** and Jeje, J.O (1996). Report on the Formulation of Soil Conservation Plan for National Agricultural Land Development Agency (NALDA) Project in Igboye – Iji, Epe LGA Lagos.

Allan, D.L., Adriano, D.C., Bezdicek, D.F., Cline, R.G., Coleman, D.C., Doran, J.W., Haberen, J., Harris, R.G., Juo, A.S.R., Mausbach, M.J., Peterson, G.A., Schuman, G.E., Singer, M.J and Karlen, D.L. (1995). SSSA statement on soil quality. In: Agronomy News, June 1995, ASA, Madison, Wisconsin, p.7.

Aransiola, E.F., Oyewusi, T.F., **Osunbitan, J.A**. and Ogunjimi, L.A.O (2019). Effect of Binders and Pressures on Physical Properties of Briquettes from Carbonized Corncob. Energy Reports, 5, 909-918.

Arnold, D.J and Briggs, G.G (1990). Fate of pesticides in soils predictive and practical aspect. In: Environmental fate of pesticide progress in pesticide Biochemistry and Toxiology, vol. 7. Ed. DH Hutson and T.R. Roberts, John Wiley and Sons, New York

Aswathanarayana, U. (1999). Soil resources and the Environment. Science Publishers Inc., Enfield, NH, USA

Bali, N. and Singla, A. Emerging Trends in Machine Learning to Predict Crop Yield and Study Its Influential Factors: A Survey. *Arch Computat Methods Eng***29**, 95–112 (2022). https://doi.org/10.1007/s11831-021-09569-8

Claude, H.P. (1970). Sprinkler irrigation. Leaflet No. 476. US Department of Agriculture, Washington, DC.

Cooperband, L. R. (2000). Composting: Art and science of organic waste conversion to a valuable soil resource. *Laboratory Medicine*, *31*(5), 283-290.

Culpin, C., (1986). Farm Machinery. 11th ed. Collins Professional and Technical Books, London, p. 55

Cunningham, W.P; Cunningham, M.A and Saigo, B.W (2005). Environmental Science: A Global Concern. 8th Ed, McGraw Hill Pub.

Doran, J.W; Coleman, D.C; Bedzicek, D.F and Stewart, B.A (eds) (1994). Defining soil quality for a sustainable environment. Soil Sci. Soc. Amer. Proc., Spec. Publ. 35, Madison, WI.

Doran, J.W and Jones, A.J (1996). Methods for Assessing Soil Quality. SSSA Spec. Publ. 49, Madison, WI

Doran, J.W and Parkin, T.B (1994). Defining and assessing soil quality. In: Doran, J.W., Coleman, D.C., Bezdicek, D.F. and Stewart, B.A. (Eds) *Defining Soil Quality for a Sustainable Environment*. Soil Science Society of America Special Publication Number 35, pp.3-21

Doran, J.W., Sarrantonio, M and Liebig, M.A (1996). Soil health and sustainability. In: Sparks, D.L. (ed.). *Advances in Agronomy*. Academic Press, San Diego, California, pp. 1-54

Faborode, M.O. (2005). Technology, Life and Living. The 183rd Inaugural lecture series of the Obafemi Awolowo University, Ile-Ife, Nigeria.

Fapohunda, H.O. (2002): Making it rain for higher farmer's harvest. The 155th Inaugural lecture series of the Obafemi Awolowo University, Ile – Ife, Nigeria.

Frost, D.R (1988). Effects on Crop Yield of Machinery Traffic and Soil Loosening. Journal of Agric. Eng. Res. 40:57-69

Ghadiri, H. and Rose, C.W. (1992a). An introduction to non-point source pollution modeling. In: Modeling Chemical Transport in Soils natural and applied contaminants (H. Ghadir and C.W Rose, eds), pp 1-14. Lewis publishers, London.

Ghadiri, H and Rose, C.W. (1992b). Modeling Chemical Transport in Soils natural and applied contaminants. Lewis publishers, London

Howeler R.H, Oates C.G, Allen A.C (2000). An Assessment of the Impact of cassava production and processing on the Environment and Biodiversity. Proceed. Validation Forum Global Cassava Dev. Strategy, 5: 1-9.

Igbeka, J.C (1986). Economic evaluation of tillage operations in some mechanized farms in Nigeria. *Agricultural Mechanization in Asia, Africa and Latin America, 17(2), 17-22*

James, L.G. (1988). Principles of Farm Irrigation Design. John Wiley, New York.

Karlen, D.L; Mausbach, M.J; Doran, J.W; Cline, R.G; Haris, R.F and Schuman, G.E (1997). Soil quality: a concept, definition, and framework for evaluation. Soil Science Society of America Journal 61, 4-10

Kordel, W.M and Kleim, H.M (1992). Determination of the fate of pesticides in outdoor lysimeter experiment. Sc.i. Total Environ. 123/124:421-434.

Kepner, R.A., Bainer, R., Barger, E.L. (1978). Principles of Farm Machinery, third ed. AVI Publishing Company Inc., West Port, CT. pp. 112-134

Lal, R (1993). Tillage effects on soil degradation, soil resilience, soil quality and sustainability. Soil & Tillage Research. 27:1-7.

Lal, R (1997). Degradation and resilience of soils. Phil. Trans. R. Soc. London (B) 352: 997-1010

Lal, R and Shukla, M.K (2004). Principles of Soil Physics. Marcel Dekker, Inc. New York, NY 10016, U.S.A.

Majumdar, D.K (2004). Irrigation Water Management, Principles and Practice. Prentice – Hall, New Delhi, India.

Michael, A.M (1999). Irrigation Theory and Practice. Vikas Publishing House, New Delhi.

Michael. A.M and Ojha, T.P (2006). Principles of Agricultural Engineering. Volume II: Surveying, Irrigation, Drainage, Soil and Water Conservation. M/s Jain Brothers (New Delhi, India, p. 366

Mohamed, A.M.O; R.N. Young; B.K. Tan; A. Farkas and L.W. Curtis (1994). Geoenvironmental assessment of a micaceous soil for its potential use as an engineered clay barrier. *Geotechnical Testing Journal, ASTM,* 17 (3): 291 – 304.

Mutcher, C.K and Young, R.A (1975). Soil detachment by raindrops: Present and ProspectiveTechnology for predicting sediment yields and sources. USDA Annual Report. Pp 5-40

Ogedengbe, M.O (1997). Nigeria's Water supply nightmare. Inaugural lecture series. No. 117, Obafemi Awolowo University, Ile-Ife.

Ohu, J.O., Ayotamuno, M.B and Folorunso, O.A (1987). Compaction characteristics of prominent agricultural soils in Borno state of Nigeria. Transactions of the ASAE, 30(6), 1575-1577.

Ohu, J.O and Folorunso, O.A (1989). The effect of machinery traffic on the physical-properties of a sandy loam soil and on the yield of sorghum in North Eastern Nigeria. Soil Till. Res., 14(4), 399-405.

Ohu, J.O and Folorunso, O.A (1989). The effect of Machinery Traffic on the Physical Properties of a Sandy Loam soil and the Yield of Sorghum in North Eastern Nigeria. Soil and Tillage Research, 13:399-405.

Ohu, J.O., Ahmed, U.I and Ekwue, E.I (1991). The Influence of Groundnut Haulms on the Compactibility and Hydraulic Properties of some Agricultural Soils in Borno State, Nigeria. Paper presented at NSAE Conference

Omotosho O**.,** Ogunwande G. and **Osunbitan J.** (2018) Effect of Carbon Depth in Diminution of Physico-Chemical Pollution Parameters in Cassava Processing Wastewater Treated by Aeration-Peroxide Oxidation Method. *Bioprocess Engineering* 2(1):10-13.

Omotosho, O. A., **Osunbitan, J. A**. and Ogunwande, G. A. (2019) Prospects of Combined Peroxide Oxidation and Aeration Treatment Processes in Abatement of Pollution Characteristics in Cassava Processing Wastewater. *Moor Journal of Agricultural Research* 20(1):148-156.

Omotosho, O. A., **Osunbitan, J. A**., Ogunwande, G. A. and Toyese F. T. (2023a). Wastewater management for irrigated farming: Composition, morphology and production level variation in *amaranthus sp.* irrigated with peroxide aeration treatment recycled cassava processing effluent. *Indian Journal of Engineering.* 20, e2ije1002. Available at https://discoveryjournals.org/ engineering/current_issue/2023/v20/n53/e2ije1002.

Omotosho, O. A., Uthman, A. C. O., **Osunbitan, J. A.**, Ogunwande, G. A. and Atta, A. T. (2023b) Heavy Metal Contamination Reduction In Agricultural Soils; A Comparative Assessment of Raw And Peroxide-Aeration Recycled Cassava Processing Effluent In: Olumurewa J.A.V., Mijinyawa, Y and Olabinjo, O. O. (eds) *Innovations in Agricultural Engineering: Solution to Food, Energy and Economic Challenges in Nigeria*. *Proceedings of Maiden Zonal Conference and 1st Annual General Meeting of the Nigerian Institution of Agricultural Engineers South West Zone*held in University of Ibadan, Oyo State. 1:353 – 363

Osunbitan, J.A. and Fapohunda, H.O. (1998). Cost comparison of different sprinkler irrigation systems. Proc. Annual Conference of the N.S.A.E., Vol 20, pp. 142 – 149.

Osunbitan,J.A (1999).Design of a Computer Aided Sprinkler Irrigation System. Unpublished MSc. Thesis submitted to the Department of Agricultural Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria.

Osunbitan,J.A and Adekalu, K.O (1999a). The effect of incorporating Organic Wastes on the Porosity of two south-western Nigeria Soil. J*ournal of Agric. Engineering and Tech.*, 7, 16 - 22.

Osunbitan,J.A and Adekalu, K.O (1999b). The effect of incorporating Organic Waste on Water Permeability of Loamy Sand soil. Proceedings of Annual Conference of the Nigerian Society of Agricultural Engineers, Vol. 21, 89 – 95.

Osunbitan, J.A. and Fapohunda, H.O. (2000a). Development of a computer algorithm for the solid set/set sprinkler irrigation system. Journal of Agricultural Engineering & Technology, Vol. 8, pp 26 – 36.

Osunbitan, J.A. and Fapohunda, H.O. (2000b). Modeling pressure variation along the lateral of center pivot irrigation system. FUTAJEET, Vol. 2, No. 2 pp 29 – 34.

Osunbitan,J.A; Olushina, J.O; Jeje, J.O; Taiwo, K.A; Faborode, M.O; and Ajibola, O.O. (**2000**). Information on micro – enterprises involved in cassava and Palm oil processing in Osun and Ondo states of Nigeria. *Technovation.* 20 (10): 577-585.

Osunbitan,J.A and Adekalu, K.O (2001). Effect of incorporating Organic Matter on the Permeability of Sandy Clay Loam and Sandy Loam Soils. *Ife Journal of Technology*,10 (1), 19 - 23.

Osunbitan, J.A. and Fapohunda, H.O. (2001). A computer algorithm for the design of center pivot sprinkler irrigation system, Journal of Agricultural Engineering and Technology, Vol. 9, pp. 64 – 73.

Osunbitan, J.A. and Fapohunda, H.O. (2002). Computer –aided sprinkler pipe size selection in Nigeria based on pressure and economic criteria, Technovation Vol. 22, pp 645-653.

Osunbitan,J.A;Adekalu, K.O and Aluko, O.B. (2002).The effect of incorporating organic Waste on the Moisture Retention of three South-western Nigeria soils. *Agric. Mech. In Asia, Africa and Latin America,* 33 (3), 11 – 15.

Osunbitan,J.A and Adekalu, K.O (2003). Runoff Sediments of Some Southwestern Nigeria Soils under different levels of Groundcover and Compaction. Proceedings of 34th Annual Conference & Expo of the International Erosion Control Association, Las Vegas, USA, 185 – 194.

Osunbitan,J.A; Oyedele, D.J. and Adekalu, K.O (2005a).Tillage Effects on Bulk Density, Hydraulic Conductivity, and Strength of Loamy Sand Soil in Southwestern Nigeria. *Soil and Tillage Research*, 82, 57 – 64.

Osunbitan,J.A; Okunade, D.A. and Fapohunda, H.O. (2005b). Evaluating the Quantity and Quality of Groundwater for Irrigation in the Basement Complex of Ile – Ife, Nigeria. *Journal of Environmental Hydrology (Electronic Journal of IAEH),* Volume 13, 1 – 8.

Osunbitan,J.A (**2007**).Simulating Soil and Groundwater contamination by Copper and Manganese from Agricultural Fungicides. Unpublished PhD Thesis submitted to the Department of Agricultural Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria.

Osunbitan,J.A; Babalola, B.A and Okunade, D.A (2008). Investigation of Quality and Usage of Groundwater near Slaughter Houses in Basement Complex of Osun State, Nigeria. *Ife Journal of Technology, Vol 17 (1), 47 – 51.*

Osunbitan,J.A (2009).Suitability of Runoff Water Quality from a Plot Treated with Cassava Effluents for Irrigation. *Journal of Environmental Hydrology (Electronic Journal of IAEH), Volume 17, Paper 18.*

Osunbitan, J.A; Adekoya, A.C and Fapohunda, H.O (2009). Computer program for the design of vegetated waterways. Proc. of 3rd International Conference of WASAE & 9th Conference of the N.I.A.E., pp. 386 – 395.

Osunbitan, J.A; Adekalu, K.O and Aina, P.O. (2011a). Adsorption Behavior of Manganese from Dithane M – 45 to Two soil types in Southwestern Nigeria. *Canadian Journal on Environmental, Construction and Civil Engineering. Vol 2, No. 5, 43 - 49.*

Osunbitan, J.A; Adekalu, K.O and Aina, P.O. (2011b). Adsorption Behavior of copper from kocide 101 in two southwestern Nigeria soils: Batch Equilibrium Test study. *Ife Journal of Technology, Vol 20 (1), 12 - 17.*

Osunbitan, J.A ; Adeboye, O.B. and Ademiju, T.S (2011c). Adsorption of Heavy Metals from Cassava Effluent to Soil Particles in the South-western Nigeria. Minia International Conference for Agriculture and Irrigation in the Nile Basin Countries, 26th -29th March 2012, El-Minia, Egypt, 926 – 932

Osunbitan, J.A andAdekalu, K.O. (2012). Yield and water use efficiency of Jute Mallow *(Corchorus Olitorus)* as influenced by Poultry waste.Minia International Conference for Agriculture and Irrigation in the Nile Basin Countries, 26th -29th March 2012, El-Minia, Egypt, 1163 – 1169.

Osunbitan, J.A. (2012**)** Short term Chemical transformation of sandy loam soil following the application of cassava waste water. *Journal of Soil Science and Environmental Management, Vol 3 No 6, 164 - 171.*

Osunbitan, J.A (2013**).** Response of Amaranthus to Irrigation and Organic Matter. *Journal of Agricultural Science and Technology*, *Vol 3No 2, 131 – 139*

Osunbitan, J.A; Adekalu, K.O and Aina, P.O. (2014). Intermittent Leaching of Copper from Copper based Fungicide through a saturated Soil Profile. *Journal of Soil Science and Environmental Management, Vol 5 (7), 83 - 91.*

Osunbitan, J.A; Omotosho, O.A and Ogungbenro, S.S. (2019). Evaluation of Soil Nutrient Variation in Amaranth sp. caused by differences in Organic Content and Irrigation Schedule. Proceedings of 20th International Conference and 40th Annual General Meeting of the Nigerian Institution of Agricultural Engineers to be held in Omu-Aran, Kwara State, 578 -584

Osunbitan, J.A and Akinyele, O.A (2020). Flow of water through soil columns as influenced by cassava wastewaters application. *International Research Journal of Environmental Sciences. Vol. 9(4), 24-37.*

Osunbitan, J.A. and Oyewusi, T.F. (2021). Response of Solanum macrocarpon to Irrigation and Organic Matter. *International Journal of Research and Innovation in Applied Science* (IJRIAS). Volume VI, Issue II, 70-74.

Oyewusi, T.F., Aransiola, E.F., **Osunbitan, J. A**. and Ogunjimi, L.A.O (2019). A Comparative Study on the Physical Properties of Briquettes from Carbonized and Uncarbonized Corncobs. Proceedings of the OAU Faculty of Tech. Conf., 7: 127-135.

Oyewusi, T.F. (2021). A Study on Compost Extract for Fertigation of Selected Vegetables. Unpublished PhD Thesis submitted to the Department of Agricultural Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria.

Oyewusi, T.F; **Osunbitan, J.A** and Adekola, T.A (2021a). Investigation into the suitability of well water near cassava processing areas for drinking and irrigation purposes. *Environmental Challenges*, 5, 22-26.

Oyewusi, T.F; **Osunbitan, J.A;** Akinleye, M.T; Salami, L.O; Joseph, O.P and Opadoja, C.O (2021b). Suitability of Opa Dam water in Ile-Ife Nigeria for drinking and irrigation purposes. Adeleke University Journal of Engineering and Technology (AUJET), Vol 4, No. 1, 40-46.

Oyewusi, T.F. **Osunbitan, J.A**., Ogunwande, G.A. and Omotosho, O.A. (2021c). Investigation into physico-chemical properties of compost extract as affected by processing parameters. Journal of Environmental Challenge, 5, 100370.

Oyewusi, T.F. **Osunbitan, J.A**., Ogunwande, G.A. Ademiju, T.A., Opadoja, C.O. and Amoo, M.O. (2023). Potential of Compost Extract on Physico-chemical Properties of Soil After Harvest. Suranaree J. Sci. Technol. 30(6):020027(1-9)

Riise, G and B. Salbu (1992). Mobility of dichlorprop in the soil water system as a function of different environmental factors. I. A. batch experiment. *The Science of the Total Environment.* 123/124, 399 – 409.

Sangodoyin, A.Y. (1993). Hand pump equipped wells for rural transformation: lesson from Oyo State. Nigerian Journal of Water Resources 1 (2), 1-12.

Schjonning, P; Elmholt, S and Christensen, B.T (2004a). Managing Soil Quality Challenges in Modern Agriculture, CABI Publishing.

Schjonning, P; Elmholt, S and Christensen, B.T (2004b). Soil Quality Management – Concepts and Terms. In: Schjonning, P; Elmholt, S and Christensen, B.T (eds). *Managing Soil Quality Challenges in Modern Agriculture*, CABI Publishing.

Sikora, L.J (1998). Benefits and Drawbacks to composting organic by-products. In: Brown, S., Angle, J.S and Jacob, L (eds). *Beneficial Co-Utilization of Agricultural, Municipal and Industrial By-Products*, Springer, 69-77.

Taiwo, K.A; **Osunbitan, J.A**; Sunmonu,O.A; Ajayi, M.O. and Ajibola, O.O. (2001). Technology Choice and Technical capacity in *Gari* Production. *Food Review International, 17 (1)*, 89 – 107.

Thibodeaux, L.J. (1996). Environmental Chemodynamics: Movement of chemicals in Air, Water and Soil. 2nd Edition. John Wiley and Sons inc. New. York, 514-540.

Warkentin, B.P (1971). Effects of compaction on content and transmission of water in Soil. In: Compaction of Agricultural Soils, ASAE Monograph, USA, 126-153