Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.8, No.12, 2018

Problems and Prospects of Soil Amendments for Soil and Water Conservation in Nigeria

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Abstract
A soil amendment or conditioner is anything added to soil that improves its physical and chemical properties. The aim of this study was to review the commonly used soil amendment in Nigeria,their effectiveness and the problems associated with their usage. The ease with which water and plant nutrients seeps beyond the plant root zone making it unavailable for plant growth and development is often corrected by applying amendments, the categories of soil amendments are broad, and may include organic amendments to change the texture of soil, fertilizers to boost the nutrient structure, cover crops to add aeration and drainage or even items that will change the pH of soil. The common soil conditioners in Nigeria are: Cow dung, poultry litters, Goat yard manure (GYM) and compost. The challenges with the use of organic amendments without proper precaution are its tendency to cause pollution to land and water especially portable water. But to a large extent, the practice is highly economical and result oriented. Some soil amendments are extremely high in salts. They are to be used with caution. Plant-based composts are low in salt.
Keywords: Biofertilizer, Soil Conditioners, Soil Amendment, Soil Conservation, Water Management, Bioremediation, soil physical properties

Introduction

The pressure of human survival and the need for additional food supplies or production require increased intensities on soil and water. Soil and water are two natural resources that are subject to depletion and degradation, therefore conservation is aimed at using these resources judiciously without wastage (Ogbe, 2008). Agriculture in Nigeria is a major branch of the economy in Nigeria. The sector is being transformed by commercialization at the small, medium and large-scale enterprise levels. Major crops include beans, sesame, cashew nuts, cassava, cocoa beans, groundnuts, maize (corn), melon, millet, palm kernels, palm oil, plantains, rice, rubber, sorghum, soybeans and yams. In 1990, 82 million hectares out of Nigeria's total land area of about 91 million hectares were found to be arable, although only 42 percent of the cultivable area was farmed. Agriculture contributed 32% to GDP in 2001. The country's agricultural products fall into two main groups: food crops produced for home consumption and exports (Wikipedia, 2016).

Most soils of Nigeria, like other parts of sub-Saharan Africa, are poor compared to most other parts of the world (Ishaku, 2008). It has been posited that lack of volcanic rejuvenation has caused the continent to undergo various cycles of weathering (breakdown of rocks into soils), erosion (loss of soil by forces of water or wind) and leaching (washing down of nutrients by water), leaving the soils poor in nutrients. The ease with which water and plant nutrients seeps beyond the plant root zone making it unavailable for plant growth and development is often corrected by applying amendments, the categories of soil amendments are broad, and may include organic amendments to change the texture of soil, fertilizers to boost the nutrient structure, cover crops to add aeration and drainage or even items that will change the pH of soil (Ishaku, 2008).

A soil amendment is anything added to soil that improves its physical and chemical properties. The categories of soil amendments are broad, and may include organic amendments to change the texture of soil, fertilizers to boost the nutrient structure, cover crops to add aeration and drainage or even items that will change the pH of soil (Stephens, *et al.,* 2009). The following are the importance of soil amendments:

i. Itprevents crusting of soil and aids seed emergence.
ii. Improves compacted Soils
iii. Makes wet soils easier to till
iv. Prevents Water Logging of Soil
v. Increases the Stability of Soil Organic Matter
vi. Improves Water-Use Efficiency
vii. Makes it Possible to Efficiently Use Low Quality Irrigation Water
viii. Provides nutrients for plant growth, Helps Plants Absorb Plant Nutrients
ix. Decreases Bulk Density of Soils
x. Balances air and water in soil, Increases infiltration
xi. Buffers soil temperatures, Increases plant available water
xii. Improves drainage Helps Earthworms to Flourish
xiii. Increases Water Retention in Soil and Increases Crop Yields.

Amendments differ from mulches in that they are added into the soil to change it(Davis, 2005). Mulch is

placed on the surface of the soil. Amendments may be comprised of organic material or inorganic material. Organic material is made up of things that were once living. Examples include compost, peat moss and cover crops. Inorganic amendments are made of items that were never alive. Examples include synthetic fertilizers and elements such as sulfur or dolomite lime that are used to change the pH of soil (Stephens, *et al.,* 2009).

Soil and Water Conservation

The problem of the removal of soil by water and wind is age-old (Nigeria Ministry of Agriculture and Natural Resources, 2009). The pressure on the arable lands is quite much and the demand for more food by the ever increasing populace is also much. Land degradation was a significant global issue during the 20th century and remains of high importance in the 21st century as it affects the environment, agronomic productivity, food security, and quality of life (Ishaku, 2008). Soil degradative processes include the loss of topsoil by the action of water or wind, chemical deterioration such as nutrient depletion, physical degradation such as compaction, and biological deterioration of natural resources including the reduction of soil biodiversity (Lal, 2001). Water is key to food security. Crops and livestock need water to grow. Irrigation now claims close to 70 percent of all freshwater appropriated for human use.

History of Soil and Water Conservation in Nigeria

The nation's three principal ecological zones are: the highly humid coastal zone in the south; the humid and sub-humid areas in the middle belt of the country and the semi-arid regions in the north broadly corresponds with the tropical rain forest, the savannah and the Sudano-Sahelian regions of Nigeria. Indigenous techniques from the pre-colonial era focused on erosion control in combination with water conservation by ridging, mulching, constructing earth bunds and terraces, multiple cropping, fallowing, and the planting of trees. Many indigenous conservation methods such as ridging, terracing, multiple cropping and fallowing were used in the pre-colonial era. In the colonial times, the British Government conducted large-scale projects of soil conservation but many failed as imported technologies were inadequate (Ishaku, 2008).

Soil fertility issues gained more emphasis after independence. Decreasing funds at the end of the oil boom in the 1980s however, restricted soil conservation schemes. In 1949, an irrigation division was established within the department of Agriculture in Northern Nigeria. In the early 1950s, the Bagaji region of the Niger saw the beginning of rice schemes and simple flood control. In 1956, hydrological stations were set up in the Lake Chad region, leading to pilot irrigation schemes on the Yobe and Ebeji rivers, and in 1959, Hydrology was also established as a division of Agriculture. At the same time, a Niger Delta Development Authority was created, which later became a model for the River Basin Development Authority System. Nigeria has no long history of extensive surface irrigation. In some regions of Nigeria, especially Lake Chad, flood-retreat cultivation is possible, although it has never become widespread (Davis, 2005).

In Sub-Sahara Africa, soil conservation has a long tradition. Indigenous techniques from the pre-colonial era focused on erosion control in combination with water conservation by ridging, mulching, constructing earth bunds and terraces, multiple cropping, fallowing, and the planting of trees. In colonial times, the British Government worked on natural resource management as interest was high in expanding commercial farming enterprises. Large-scale projects on soil loss control were started, especially in areas of high agricultural potential, but many of them failed as the imported technologies had little relevance in the tropics and were not adopted later by local farmers. After independence in 1960, more emphasis was laid on soil fertility issues. Decreasing funds at the end of the oil boom in the 1980s additionally restricted the performance of soil conservation schemes. Today, the seriousness of this environmental problem still exists and is also recognized by the Federal Government of Nigeria that planned to spend about half a million US dollars on soil erosion projects all over the country in 2007 (Ishaku, 2008).

Types of Soil Amendments used in Nigeria

The categories of soil amendments used in Nigeria areorganic and inorganic soil conditioners, especially in the north where soil cultivation goes on round the year, rainfed during rainy season and irrigation in the dry season: Organic amendments come from something that was alive. Inorganic amendments, on the other hand, are either mined or man-made. Organic amendments include sphagnum peat, wood chips, grass clippings, straw, compost, manure, biosolids, sawdust and wood ash. Inorganic amendments include vermiculite, perlite, tire chunks, pea gravel and sand. Organic amendments increase soil organic matter content and offer many benefits. Over time, organic matter improves soil aeration, water infiltration, and both water- and nutrient-holding capacity. Many organic amendments contain plant nutrients and act as organic fertilizers (Ishaku, 2008).

Brief description and NPK ratings of some Amendments used in Nigeria

i. **Chicken:** All birds have relatively high metabolisms and body temperatures. The manure of all poultry (turkeys, pigeons etc) is a combination of feces and urine, and it's extremely high in nitrogen.

As a fertilizer, mature chicken manure has an NPK rating of 1/1.5/0.5.

ii. **Cow:** This may be the most balanced of all manures for organic growing because of the nature of cows' stomachs. Composted steer manure typically has an NPK rating of 0.8/0.5/0.5.
iii. **Horse:** Horses digest their food less thoroughly than cows, so their manure is richer in organic matter. Expect an NPK rating of 0.5/0.3/0.4.
iv. **Pig:** Organically farmed pig manure is an excellent amendment with an NPK averaging 0.6/0.4/0.3.
v. **Sheep:** Like cows, these animals digest their food well. Their potassium rich fertilizer has an NPK rating of 0.4/0.3/0.8.
vi. **Rabbit:** Rabbit pellets are high in nitrogen and phosphorus. In a food growing system, it's probably safer to compost rabbit pellets before use. Its NPK rating is 2/1.4/0.6.
vii. **Mushroom manure:** Organic mushroom manure is an outstanding soil amendment with an NPK of 0.7/0.3/0.3. Mushroom manure that is not specifically listed as organic may contain traces of pesticide residues used to control fungus gnats.
viii. **Green Manure** -- Grass and weeds that have been cut from lawns or pulled from your garden make good humus. Green manure helps to add body to sandy soil.
ix. **Human:** While the thought of using human waste in food production may be offensively unpalatable to Western growers, it's worth considering that such waste is far too valuable in some parts of the world to waste by simply polluting rivers. Human manure can, indeed, be composted and spread for crop production. Human urine is extremely high in nitrogen, and has its uses in the garden as well.
x. **Compost:** Compost refers to decomposed organic matter. It is not regulated, so there is no standard about the state of decomposition. In commercially available products the term "compost" is often used generically, and does not infer that the product has been through the actively heating, decomposition process.
xi. **Others:** (Wood ash, agricultural wastes like chaffs, saw dust e.t.c)

The Process of Soil Amendment

Soil amendment process typically involves the following steps:

i. Initial soil disturbance.
ii. Breaking up of the subsoil.
iii. Rock removal (where relevant).
iv. Distribution of soil amendment agent.
v. Soil integration, Grading and mixing of the soil with the amendment.

SELECTED STUDIES ON SOIL AMENDMENT IN NIGERIA

BENEFICIAL EFFECT	AUTHOR(S)	LOCATION	KIND OF AMENDMENT
Thesoilamendment promotedwater-retention tomaintainablanketofmoistsoilat depthsnearthesurface.	Ramalan (2003)	Zaria, Nigeria	Alcosorb400
Yields comparable to chemical fertilizer which are popular among Nigerian farmers were obtained when the palm kernel waste was composted.	Kolade *et al.,* (2005)	Ondo, Nigeria	Palm kernel wastes
Cattle and pig manure significantly increased water storage capacity	Babatunde (2008)	South west Nigeria	Cattle and Pig Manure
Higher value of $Ca^{2+}$$Mg^{2+}$, K^{+} and Na^{+} in waste amended soil compared to the control.	Mbah, *et al.,* (2009)	Abakaliki, Ebonyi state.	Rice Mill Waste
The results indicated that high-quality okra pods could be effectively produced in soils treated with sewage sludge.	**Adewole and Ilesanmi (2011)**	Ile-Ife Nigeria	Compost organic fertilizer (OR), *Glomusmosseae*mycorrhiza (MY)
Results of the study showed significant difference in soil pH ,ECEC (Cmolkg-1),OM%, total N%, aggregate stability%, among treatments.	Ndubuisi and Deborah (2009)	Umudike, Abia State	Wood ash

Long yam bean could substitute for 250kg/ha NPK fertilizer	Emmanuel & Adekayode(2010)	Akure	Long yam bean (*Sphenostiliessternocarpa*)
Application of 20 t ha^{-1} of poultry manure increased the Fe-P availability.	Ojo, *et al.,* (2010)	Ibadan	With poultry manure and single superphosphate
Poultry litter can be used effectively as an organic soil amendment to supply nutrients to the crop and suppress.	Orisajo*et al.,* (2008)	Ogun state	Effects of poultry litter and carbofuran soil amendments
Compost amendment at 20 tons ha-1 produced the highest yield of *Celosia*	Shokalu, *et al.,* (2010)	Idi-Ishin Ibadan	*Tithoniadiversifolia* and Compost
Analysis showed that the organic amendments has influence on the growth of Zea mays	ChiomaOkore *et al.,* (2012)	Nekede, OwerriImo state	Goat droppings, chicken litter and sawdust
The amendments showed a difference in number of panicle, panicle length, chaff weight, grain weight and stover weight.	Sadiq*et al.,* (2012)	Maiduguri, Borno State	Saw Dust, cow dung and poultry droppings
Higher number of *Gnetumafricanum* plantlet establishment in the field than the other treatments	*Ibeawuchi, et al., (2008)*	Owerri	kitchen ash, poultry manure
The application of cow dung increased the soil total percent nitrogen, available phosphorus, exchangeable potassium.	Gana (2011)	Badeggi, Niger state	Cow dung
The study after six weeks showed that 4 t PM/ha gave the highest concentrations of P, Ca and Mg in the soil.	Okonwu and Mensah (2012)	Portharcourt, Rivers state	POULTRY MANURE
The plant height, leaf area, stem girth and weight of roots, shoot and grain yield were significantly increased	Agbede*et al.,* (2008)	Akure, Ondo state	Poultry manure
The study revealed a superiority of RHA over the other ash sources in the improvement of most of the plant nutrients.	Nwite (2011)	Afikpo, Ebonyi state	Rice husk ash-RHA, wood ash-WA, and leaf ash-LA
NPK + cattle manure mixture appeared to be the most beneficial application compared with the other treatments.	Okwuagwu*et al.,*(2003)	Ekpoma, Edo state	cattle-manure, NPK and NPK + cattle manure mixture
Poultry manure significantly enhanced the growth and seed yield characteristics of maize.	Kayode*et al.,* (2012)	Southern Guinea savanna zone of Nigeria	Poultry manure and NPK
Cowpea chaff can be used to enhance biodegradation of diesel polluted soil	Stephen *et al.,* (2013)	Ayimgba, Kogi state	Cowpea Chaff
Thehighestmeanyield of16.3 tha^{-1} obtainedwith6.0tha^{-1} ofMYwasnotsignificantlyhigherthan15.4t ha^{-1}	Moses and Abiola (2012)	Ile ife, Nigeria	Compostorganic fertilizer(OR),*Glomusmosseae*mycorrhiza(MY)
The organic matter content ranged from 2.03% in neem leaves to 22.05% in sheep dung, sodium ranged from 0.39 cmol/kg in millet husk to 7.10 cmol/kg in refuse dump, total nitrogen values ranged from 0.30% in wood ash to 1.42% in poultry manure.	Audu, and Zubairu (2013)	Sokoto, Nigeria	Neem leaves, Neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk
Gall index was significantly reduced in the root of Sesame as a result of compost soil amendments with *T. harzanium*mixture	Timothy and Adeola (2013)	Ogbomosho, Nigeria	*Tithonia*leaf, Neem leaf, with *Trichodermaharzanium*mixture

PM gave the best significant value for the leaf height, leaf length and stem girth.	Senjobi *et al.,* (2012)	Abeokuta, Nigeria	Poultry manure and cow dung
The superior performance of 5.0 t ha-1 PM + 5.0 t ha-1 WA was adduced to increased availability of nutrients following the inclusion of PM.	Agbede and Adeyinka (2012)	Akure, Nigeria	Wood ash, poultry manure and NPK fertilizer
The application of agro-industrial wastes and poultry manure resulted in differences in the population of the classes of bacteria and fungi isolated from the waste and manure amended soils.	Eneje and Ifenkwe (2012)	Umudike, Abia state, Nigeria.	Palm oil mill effluents, cassava mill effluents, and sawdust wastes and poultry manure
AM-PM treatment produced significantly higher weight of pod per plant suggesting that AM-PM treatment has high potential in influencing high crop yield.	Nwangburuka *et al.,* (2012)	Ilishan-Remo, Ikeja, Lagos	Arbuscularmycorrhizae (AM), Poultry manure (PM), Combination of AM-PM.
Both supplements improved the soil properties in the varieties studied but the stimulation was more with organic supplements	Okon*et al.,* (2013)	Uyo, Nigeria	Goat manure and NPK
This study concludes that Spent Mushroom Substrates could serve as organic fertilizer.	Olutayo & Orluchukwu (2013)	Port-Harcourt, Nigeria	Spent Mushroom Substrate
Compost at 5 and 10 t ha-1 gave a significant increase in okra pod counts and weight and both were greater than the fresh pod weight obtained from NPK.	Aiyelari *et al.,* (2012)	Ibadan Nigeria	*Terminaliacatappa leaves composted with poultry manure*
The variation of infiltration under GYM amendment was superior to the use of poultry waste.	Essien (2011)	Uyo Nigeria	goatyard manure (GYM) and poultry waste
Cow dung, spent mushroom and poultry droppings are effective nutrient sources for bioremediation.	Ibiene (2011)	Odi, Bayelsa state, Nigeria.	Spent mushroom, cow dung and poultry droppings

Factors to consider when choosing an Amendment

There are at least four factors to consider in selecting a soil amendment:

i. How long the amendment will last in the soil
ii. Soil texture
iii. Soil salinity and plant sensitivities to salts and,
iv. Salt content and pH of the amendment.

Laboratory tests can determine the salt content, pH and organic matter of organic amendments. The quality of bulk organic amendments for large-scale landscape uses can then be determined (Davis, 2005).

Cost of Amendments

Soil amendments and conditioners are relatively inexpensive compare to inorganic fertilizers, the costs involved includes purchasing, transportation and application of the amending agents, monitoring the effectiveness of pollutant removal, and replacement of amended soil if its pollutant removal capacity diminishes over time.

Purpose and Uses of Soil Amendments

i. **Soil texture and structure:** The most common use of soil conditioners is to improve soil structure. Soils tend to become compacted over time. Soil compaction impedes root growth, decreasing the ability of plants to take up nutrients and water. Soil conditioners can add more loft and texture to keep the soil loose.
ii. **Soil nutrients:** For centuries man has been adding things to such poor soils to improve their ability to support healthy plant growth. Some of these materials, such as compost, clay and peat, are still used extensively today. Many soil amendments also add nutrients such as carbon and nitrogen, as well as

beneficial bacteria.

iii. **Cation exchange:** Soil amendments can also greatly increase the cation exchange capacity of soils. Soils act as the storehouses of plant nutrients. The relative ability of soils to store one particular group of nutrients, the cations, is referred to as cation exchange capacity or CEC.

iv. **Water retention:** Soil conditioners may be used to improve water retention in dry, coarse soils which are not holding water well. The addition of organic material for instance can greatly improve the water retention abilities of sandy soils and they can be added to adjust the pH of the soil to meet the needs of specific plants or to make highly acidic or alkaline soils more usable.

Challenges associated with the use of Soil Amendments

The following challenges may need to be addressed to improve implementation, where approved soil amendment application is appropriate:

i. In urban areas and sensitive environments, such as Public Drinking Water Source Areas, and adjacent to conservation value wetlands, waterways and native vegetation, there may be constraints placed on the widespread use of soil amendment agents.

ii. Determine the phosphorus retention capacity of the amendment agents, as these can vary considerably.

iii. Amended soils may release bound phosphorus if conditions become anaerobic. This limits the use of soil amendment to levels above the groundwater saturation zone.

iv. There is potential for release of phosphorus from amended soils if the pH of the storm water becomes too acidic (e.g. pH < 5).

v. Some areas may be unsuitable for the application of soil amendment agents, such as areas with acidic or alkaline parent soils that may mobilize heavy metals in some amendment agents.

vi. Amendment may reduce the permeability of some soils (e.g. sandy soils), and reduce groundwater recharge. Reduced groundwater recharge could adversely affect the health of groundwater dependent ecosystems that exist nearby. A buffer zone around such ecosystems may be required.

vii. Amended soils have a finite effective lifespan, if nutrients are not recycled by plants and microorganisms.

viii. Care is needed to prevent the introduction of contaminants in the amendment agents (e.g. heavy metals, poly aromatic hydrocarbons, radio-active materials, pathogens), that may be hazardous to human health, particularly in the context of residential premises where children or animals may ingest soil and vegetables may be grown. Care is required in what material is used and where.

Conclusion

The practice of soil amendment is a good strategy for conserving soil and water for sustained agricultural production. On clayey soils, soil amendments improve the soil aggregation, increase porosity and permeability, and improve aeration, drainage, and rooting depth. On sandy soils, soil amendments increase the water and nutrient holding capacity. A variety of products are available bagged or bulk for soil amendments. However, soil amendments are not regulated. Many are extremely high in salts. Manure and manure-based compost are readily available. These are often high in salts, limiting their application rates. They are to be used with caution. Plant-based composts are low in salt. These may be applied at higher application rates, more effectively improving the soil.

References

Adewole M. B. and A. O. Ilesanmi "Effects of soil amendments on the nutritional quality of okra (Abelmoschusesculentus [L.]Moench)" Journal of soil science and plant nutritionJ. Soil Sci. Plant Nutr. vol.11 no.3 Temuco 2011 Journal of Soil Science and Plant Nutrition, 2011, 11 (3), 45-55

Agbede T. M. and A. O. Adekiya (2012) "Effect of wood ash, poultry manure and NPK fertilizer on soil and leaf nutrient composition, growth and yield of okra (*Abelmoschusesculentus*)" Emir. J. Food Agric. 2012. 24 (4): 314-321.

Agbede, T.1 M., 2Ojeniyi, S.O. and 2AdeyemoA.J. (2008) "Effect of Poultry Manure on Soil Physical and Chemical Properties, Growth and Grain Yield of Sorghum in Southwest, Nigeria" American-Eurasian Journal of Sustainable Agriculture, 2(1): 72-77, 2008 ISSN 1995-0748 © 2008, American Eurasian Network for Scientific Information

AiyelariE.A., A. Ogunsesi and O.O. AdeOluwa(2012) Effects of *TerminaliaCatappa*leaves with Poultry Manure compost, Mulching and Seedbed preparation on the Growth and Yield of okra (*Abelmoschusesculentus*l. Moench) JournalofAgricultural Sciences Vol.57,No.4,2012 Pages 143-153.

Audu M., and ZubairuAliyu (2013) "Analysis of Nutrient Content of Some Organic Materials for Soil

Amendment in SokotoMetroplis, Nigeria" Journal of Biology, Agriculture and Healthcare ISSN 2224-3208 (Paper) Vol.3, No.18, 2013.

Babatunde S. E. (2008) "Organic matter and okra growth and yield examination on sandy loam soil amended with in cattle and pig manure humid Southwest Nigeria" Journal: Food, Agriculture and Environment (JFAE) Year: 2008, Vol. 6, Issue 2, pages 197-200.

ChiomaOkore, OgeMbanefo, Sam Adeyemo, Bright Onyekwere and Simon Onyewenjo (2012) "The Effect of Mixed Organic Amendments on the Shoot Length of Zea Mays Grown in Condemned Engine Oil Polluted Soil" 2012 4th International Conference on Agriculture and Animal Science IPCBEEvol.47 (2012) © (2012) IACSIT Press, Singapore DOI: 10.7763/IPCBEE. 2012. V47. 12.

Davis, J. G. (2005) "Choosing a Soil Amendment" Colorado State University Extension

Emmanuel I. M. and F. O. Adekayode(2010) "Use of Long Yam Bean (Sphenostylisstenocarpa) as Soil Amendment for the Growth, Leaf Chemical Composition and Yield of White Yam (Dioscorearotundata L) International Journal of Plant & Soil Science, ISSN: 2320-7035,Vol.: 3, Issue.: 1 (January-February) 2010;6(11):10-17]. (ISSN: 1545-1003).

EnejeRoseta C and Ifenkwe Innocent (2012) "MICROBIAL POPULATION AND DIVERSITY IN SOILS AMENDED WITH AGROINDUSTRIAL WASTES AND POULTRY MANURE" International Journal of Agricultural Science and Bioresource Engineering Research Vol. 1 (5), pp. 78 - 86, Sept. - Oct., 2012.

Essien O. E. (2011) "EFFECT OF VARYING RATES OF ORGANIC AMENDMENTS ON POROSITY AND INFILTRATION RATE OF SANDY LOAM SOIL" The Journal of Agriculture and Environment Vol:12, Jun.2011 Technical Paper.

Ibeawuchi I. I, ObiefunaJ.C, NjokuOnyinyechiIta, OnyiaVN, Uzoho B. U. "Soil amendments for enhanced field establishment and yield of *Gnetumafricanum*(Okazi) plantlets in Owerri, Southeastern Nigeria" Life Science Journal. 2008; 5(2): 63 – 69] (ISSN: 1097 – 8135).

Ibiene, A. A., Orji, F. A., Ezidi, C. O. and Ngwobia, C. L.(2011) "BIOREMEDIATION OF HYDROCARBON CONTAMINATED SOIL IN THE NIGER DELTA USING SPENT MUSHROOM COMPOST AND OTHER ORGANIC WASTES" Nigerian Journal of Agriculture, Food and Environment. 7(3):1-7 Published September, 2011 .

IshakuAmapu (2008) "Improving productivity of Nigerian soil" AkwaIbom online website. Copy right 2012 Government of AkwaIbom state.

IshakuAmapu (2008) "Improving productivity of Nigerian soil" AkwaIbom online website. Copy right 2012 Government of AkwaIbom state.

KayodeOgundare, Samuel Agele and Peter Aiyelari (2012) "Organic amendment of an ultisol: effects on soil properties, growth, and yield of maize in Southern Guinea savanna zone of Nigeria" International Journal of Recycling of Organic Waste in Agriculture 2012, 1:11 http://www.ijrowa.com/content/1/1/11.

Kolade O. O., A O Coker, M K C. Sridhar and G. O. Adeoye(2005) "Palm kernel waste management through composting and crop production Volume:5Issue:2".

Lal, R. 2001. Soil Degradation by Erosion. Land Degradation and Development 12: 519-539.

Mbah C. N., NwekeA.I. and Njoku C. (2011) "Potentials of rice mill waste as soil amendment: Part 2: Effect on corn growth and changes in selected soil chemical properties" International Research Journal of Agricultural Science and Soil Science Vol.2(2), pp. 072-076, February 2012 .

Mbah Charles Ndubuisi and Nkpaji Deborah (2009) "Response of Maize (Zea mays L) to Different Rates of wood-ash Application in acid Ultisol in Southeast Nigeria" Marsland Press Journal of American Science 2009;5(7):53-57.

Moses B. Adewole and Abiola O. Ilesanmi (2012) "EFFECTS OF DIFFERENTSOIL AMENDMENTSONTHE GROWTH ANDYIELD ofOKRAINATROPICALRAINFOREST OF SOUTHWESTERN NIGERIA" JournalofAgricultural Sciences Vol.57,No.3,2012 Pages 143-153.

Nigeria Ministry of Agriculture and Natural Resources(2009) " Assessment of Soil Degradation in Nigeria" Federal Department of Agricultural Land Resources final report Volume 1 – text SSCSatellitbild in co-operation with SWECO International and Niger Surveys and Consultants Kiruna January 1999.

Nwangburuka C. C., O. J. Olawuyi2, K. Oyekale, K. O. Ogunwenmo, O. A. Denton and E. Nwankwo(2012) "Growth and yield response of *Corchorusolitorius*in the treatment of *Arbuscularmycorrhizae*(AM), *Poultry manure* (PM), Combination of AM-PM and Inorganic Fertilizer (NPK)" Advances in Applied Science Research, 2012, 3 (3):1466-1471 Pelagia Research Library

Nwite J.C., S.E. Obalum, C.A. Igwe, E.N. Ogbodo, 1 2 2 3 1C.I. Keke, 1B.A. Essien and 4T.Wakatsuki (2012) "Sawah Rice System, a Technology for Sustainable Rice Production and Soil Chemical Properties Improvement in Ebonyi State of Southeastern Nigeria" World Journal of Agricultural Sciences 8 (4): 351-358, 2012.

Ogbe V. B(2008) "evaluation of water advance models for furrow irrigation system" M.Sc Thesis department of agricultural engineering, Abu Zaria.

Ojo A. O., M. T. Adetunji, K. A. Okeleye and C. O. Adejuyigbe (2010) "Changes in Phosphorus Fractions in Manure and Phosphorus Fertilizer Amended Soil of Southwestern Nigeria" American journal of sciences Vol 13 No. 5(2010).

Okon, J. E., Mbong, E. O. ,Ebukanson, G. J. andUneh, O. H. (2013) "Influence of nutrient amendments of soil quality on germination, growth and yield components of two varieties of okra (Abelmoschusesculentus (L.) Moench)" E3 Journal of Environmental Research and Management Vol. 4(3). pp. 0209-0213, April, 2013.

Okonwu K. and S. I. Mensah (2012) "STUDIES ON SOIL AMENDED WITH POULTRY MANURE AND ITS EFFECTS ON YIELD AND YIELD COMPONENTS OF PUMPKIN" *Scientia Africana, Vol. 11 (No.1), June 2012. pp 84-91 © Faculty of Science, University of Port Harcourt, Printed in Nigeria ISSN 1118 – 1931*

OkwuagwuM.I., M.E. Alleh, & I. O. Osemwota (2003) "The effects of organic and inorganic manure on soil properties and yield of okra in Nigeria" African Crop Science Conference Proceedings, Vol. 6. 390-393.

Olutayo M. Adedokun and J. A. Orluchukwu (2013) " Pineapple: Organic Production on Soil amended with Spent Mushroom Substrate" AGRICULTURE AND BIOLOGY JOURNAL OF NORTH AMERICA ISSN Print: 2151-7517, ISSN Online: 2151-7525, doi:10.5251/abjna.2013.4.6.590.593 ©2013,ScienceHuβ, http://www.scihub.org/ABJNA.

OrisajoS.B., AfolamiS.O., Fademi O. and AtungwuJ.J.(2008) "Effects of poultry litter and carbofuran soil amendments on Meloidogyne incognita attacks on cacao" *Journal of Applied Biosciences (2008), Vol. 7: 214 – 221. ISSN 1997 – 5902.*

RamalanA.A. (2003) "The effect of soil amendment and irrigation schedule on growth and yield of onion (Allium cepa L.) and seasonal irrigation applied" Journal of Food, Agriculture & Environment, Vol.1 (3&4), August-December 2003.

SadiqK.A, I.S. Dalatu and A.B. Mustapha (2012) "The Effect of Incorporation of Saw Dust into Two Types of Organic Manure on the Growth and Yield Of Pearl Millet at Njimtilo Village in the Dry Sud-Humid Region of Borno State of Nigeria" 2012 2nd International Conference on Environment Science and Biotechnology IPCBEEvol.48 (2012) © (2012) IACSIT Press, Singapore DOI: 10.7763/IPCBEE. 2012. V48. 12

Senjobi, B.A, Akinsete, S.J, Ande, O.T and Ademoye, O.A (2012) "Sandy Soil Improvement Using Organic Materials and Mineral Fertilizer on the Yield and Quality of Jute Plant (CorchorusOlitorius)" Journal of Biology and Life Science ISSN 2157-6076 2013, Vol. 4, No. 1

Stephen, E., Job, O.S., Abioye, O.P (2013) "Study on Biodegradation of Diesel Contaminated Soil Amended with Cowpea Chaff" Journal of Science & Multidisciplinary Research Vol. 2(1), pp14-18, March, 2013 ©International Research Journal Group.

Stephen, E., Job, O.S., Abioye, O.P (2013) "Study on Biodegradation of Diesel Contaminated Soil Amended with Cowpea Chaff" Journal of Science & Multidisciplinary Research Vol. 2(1), pp14-18, March, 2013 ©International Research Journal Group.

Timothy IpoolaOlabiyi and AdeolaRukayatGbadamosi (2013) "The Effect of Four Compost Soil Amendments Based on Trichodermaharzianum on Nematode Pests of Sesame" International Journal of Agronomy and Plant Production. Vol., 4 (S), 3859-3863, 2013

Wikipedia (2016). The free encyclopedia