American Economic & Social Review; Vol. 2, No. 1; 2018
ISSN 2576-1269 E-ISSN 2576-1277
Published by Centre for Research on Islamic Banking & Finance and Business

Economic System and Environment: Co-Composting Effect of Prosopis Africana and Cow Dung

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Received: January 16, 2018 Accepted: January 19, 2018 Online Published: January 28, 2018

Abstract
An economic system is comprised of the various processes of organizing and motivating labor, producing, distributing, and circulating of the fruits of human labor, including products and services, consumer goods, machines, tools, and other technology used as inputs to future production, and the infrastructure within and through which production, distribution, and circulation occurs. Natural environment refers to climate, weather, and natural resources that affect human survival and economic activity. The natural environment is an important component of the economic system, and without the natural environment the economic system will not be able to function. Hence, in recent years economists have started treating the natural environment in the same way as they treat labor and capital as an asset and a resource. Composting is a biological conversion of heterogeneous organic substrate under controlled conditions, into a hygienic, humus rich and relatively bio-stable product that conditions soil and nourishes plants. The use of compost as a soil conditioner, a fertilizer, or a growth medium has, of course, significant environmental benefits. However, there are also negative impacts on the environment associated with making and using compost. The overall aim of this study is to understand the physicochemical changes such as temperature, conductivity, pH, loss in weight and moisture content that occur during the co-composting of Prosopis Africana shell with cow dung and to assess the way in which these factors influence the quality of the resulting compost and the environment.

Keywords: Economic System, Environment, Co-Composting, Prosopis Africana, Cow Dung.

1. Introduction

An economic system is comprised of the various processes of organizing and motivating labor, producing, distributing, and circulating of the fruits of human labor, including products and services, consumer goods, machines, tools, and other technology used as inputs to future production, and the infrastructure within and through which production, distribution, and circulation occurs. These processes are overdetermined by the political, cultural, and environmental conditions within which they come to exist (Mtholyoke, n.d.).

The natural environment is a state in which all living and nonliving things occur in a particular region (The DynamicNature, 2014). According to business dictionary (n.d.), natural environment refers to climate, weather, and natural resources that affect human survival and economic activity. The natural environment is an important component of the economic system, and without the natural environment the economic system will not be able to function. Hence, in recent years economists have started treating the natural environment in the same way as they treat labor and capital as an asset and a resource (*HigheredMheducation*, n.d.).

The maintenance of good soil quality is vital for the environmental and economic sustainability of annual cropping (ARCGIS, n.d.). Composting is a biological conversion of heterogeneous organic substrate under controlled conditions, into a hygienic, humus rich and relatively bio-stable product that conditions soil and nourishes plants (Kalaiselvi and Ramasamy, 1996). Co-composting means the composting of two or more raw materials together (SNV, 2016). Co-composting, as ordinary composting is an effective strategy for diverting several types of waste from landfills, while transforming them into valuable resources (Dinis, 2009). According to Manderson (n.d.), compost is the product of the controlled microbial degradation of heterogeneous organic matter into a safe and beneficial humus-like material. The use of compost as a soil conditioner, a fertilizer, or a growth medium has, of course, significant environmental benefits. In addition to returning nutrients to the soil and thus permitting the reduction of artificial fertilizers, compost is waste that does not have to be landfilled. When it is used as daily cover at landfills, it replaces other materials that would otherwise be used for that purpose (UNEP, n.d.).

However, there are also negative impacts on the environment associated with making and using compost. These impacts depend both on the technical approach used and the waste composition of the input streams. Mixed municipal solid waste (MMSW) and sewage sludge composting pose greater risks because these materials typically contain higher levels of heavy metals than do kitchen or yard wastes(UNEP, n.d.).

In this study, co-composting of two feedstock was carried (Prosopis Africana shell and cow dung). Prosopis Africana is a flowering plant species in the genus Prosopis found growing wild in Northern and the Middle-Belt of Nigeria. The proximate composition of the nutritional and functional properties of Prosopis Africana is as follows: moisture, total ash, ether extract, crude protein, crude fibre and carbohydrate, that is, 1.9, 4.4, 12.8, 23.6, 3.3 and 54.0g % respectively (Aremu et al., 2007). The seeds contained 20.54, 5.67 and 6.51 g/100 g of protein, ash and fiber, respectively (Barminas, 1998).

The use of cattle manure, or cow dung, in the farms or garden is a popular practice in many rural areas of Nigeria. Cow dung provides high levels of organic materials and rich in nutrients. It contains about 3 percent nitrogen, 2 percent phosphorous, and 1 percent potassium (3-2-1 npk). In addition, one of the other advantages it is very useful for the farmers to use cow dung manure because it contains high levels of ammonia which is potentially dangerous for pathogens (Atulesh, n.d.). By combining the two feedstock/raw materials during composting, the benefits of each can be used to optimize the process and the product (compost).

Generally speaking, this study attempts to determine the physical and chemical transformations that occur during the co-composting of Prosopis Africana shell with cow dung and to assess the way in which these factors influence the quality of the resulting compost and the environment. This investigation is important in enabling us know whether or not compost cannot be considered potentially detrimental or dangerous for the environment or for the human health.

2. Nigerian Economy and Physical Environment

Economy

Nigeria is the most populous country within OPEC. It has around 177 million inhabitants. Located on the Gulf of Guinea on Africa's western coast, Nigeria covers an area of around 924 thousand square kilometers **(OPEC,** 2018). Nigeria is a middle-income, mixed economy and emerging market, with expanding manufacturing, financial, service, communications, technology and entertainment sectors. It is ranked as the 21st-largest economy in the world in terms of nominal GDP, and the 20th-largest in terms of purchasing power parity. It is the largest economy in Africa; its re-emergent manufacturing sector became the largest on the continent in 2013, and it produces a large proportion of goods and services for the West African subcontinent (Wikipedia, n.d.a). In addition, the debt-to-GDP ratio is 11 percent, which is 8 percent below the 2012 ratio (Reuters Staff , 2014).

Nigerian GDP at purchasing power parity (PPP) had almost tripled from $170 billion in 2000 to $451 billion in 2012, although estimates of the size of the informal sector (which is not included in official figures) put the actual numbers closer to $630 billion. Correspondingly, the GDP per capita doubled from $1400 per person in 2000 to an estimated $2,800 per person in 2012 (again, with the inclusion of the informal sector, it is estimated that GDP per capita hovers around $3,900 per person). The Table 1 shows a trend of gross domestic product of Nigeria at market prices estimated by the International Monetary Fund with figures in USD billions (IMF, 2006). Figures before 2000 are backwards projections from the 2000–2012 numbers, based on historical growth rates, and should be replaced when data becomes available. The figure for 2014 is derived from a rebasing of economic activities earlier in the year.

Table 1: Economic Indicators of Nigeria

Year	Gross Domestic Product, (PPP, In Billions)	US Dollar Exchange	Inflation Index (2000=100)	Per Capita Income (As % Of USA)
1980	*58	1 Naira	1.30	7%
1985	*82	3 Naira	3.20	5%

1990	*118	9 Naira	8.10	2.5%
1995	*155	50 Naira	56	3%
2000	170	100 Naira	100	3.5%
2005	291	130 Naira	207	4%
2010	392	150 Naira	108	5%
2012	451	158 Naira	121	7%
2014	972	180 Naira	(no data)	11%

Source: Wikipedia (n.d.a).

Although oil revenues contribute 2/3 of oil revenue (Wikipedia, n.d.a), oil only contributes about 9% to the GDP. Nigeria produces only about 2.7% of the world's oil supply (in comparison, Saudi Arabia produces 12.9%, Russia produces 12.7% and the United States produces 8.6%)(Wikipedia, n.d.b). Although the petroleum sector is important, as government revenues still heavily rely on this sector, it remains a small part of the country's overall economy(see Figure 1 for general economic activities in Nigeria).According to a Citigroup report published in February 2011, Nigeria will get the highest average GDP growth in the world between 2010 and 2050 (Wikipedia, n.d.a). Nigeria is one of two countries from Africa among 11 Global Growth Generators countries.

In spite of the oil, agriculture remains the base of the Nigerian economy, providing the main source of livelihood for most Nigerians. The sector faces many challenges, notably an outdated land tenure system that constrains access to land (1.8 ha/farming household), a very low level of irrigation development (less than 1 percent of cropped land under irrigation), limited adoption of research findings and technologies, high cost of farm inputs, poor access to credit, inefficient fertilizer procurement and distribution, inadequate storage facilities and poor access to markets have all combined to keep agricultural productivity low (average of 1.2 metric tons of cereals/ha) with high postharvest losses and waste (FAO, 2018).

Even though agriculture still remains the largest sector of the Nigerian economy and employs two-thirds of the entire labour force, the production hurdles have significantly stifled the performance of the sector. Over the past 20 years, value-added per capita in agriculture has risen by less than 1 percent annually. It is estimated that Nigeria has lost USD 10 billion in annual export opportunity from groundnut, palm oil, cocoa and cotton alone due to continuous decline in the production of those commodities. Food (crop) production increases have not kept pace with population growth, resulting in rising food imports and declining levels of national food self-sufficiency. The main factors undermining production include reliance on rainfed agriculture, smallholder land holding, and low productivity due to poor planting material, low fertilizer application, and a weak agricultural extension system amongst others (FAO, 2018).

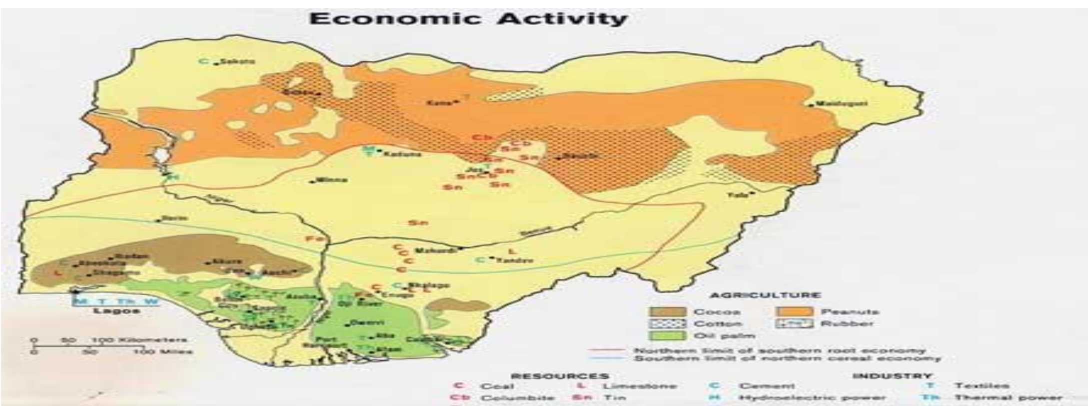

Figure 1: Map of Nigeria showing economic activities

Source: Aregheore (n.d.).

Physical Environment

Due to its peculiar geographical, geological and geomorphological setting, the Nigerian environmental system is characterized by the combination of natural features that make it uniquely susceptible and highly fragile. In ecological terms, Nigeria is a land of extremes and had remained constantly at risk for ages, with the more recent phenomenon of global warming further accentuating the rate of environmental degradation. Some of these unique features include:

(a) Nigeria is bounded in the south by over 850km long active coastline and in the north by a similar length of the Sahara Desert (see Fig. 2). The country is therefore permanently being ravaged by coastline erosion to the south as well as desertification to the north. Global warming is now acting as a catalyst to these two destructive natural forces. Thus, while coastal inhabitants are under constant threats of sea-level rise, and coastal erosion, Nigerians who dwell along the fringes of the Sahara are under the unabating threats of desertification.

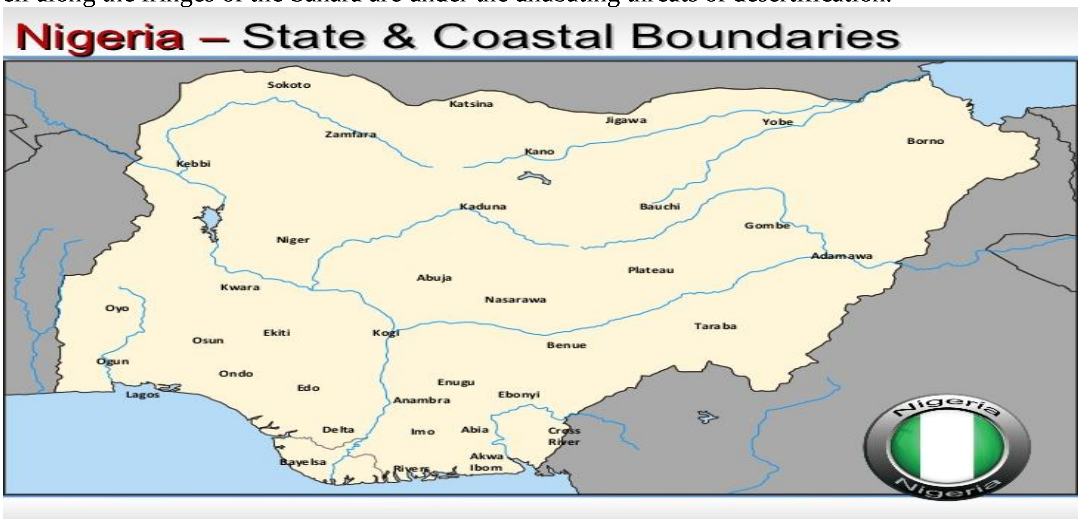

Figure 2 : Nigeria: State and Coastal Boundaries

Source: Google(n.d.).

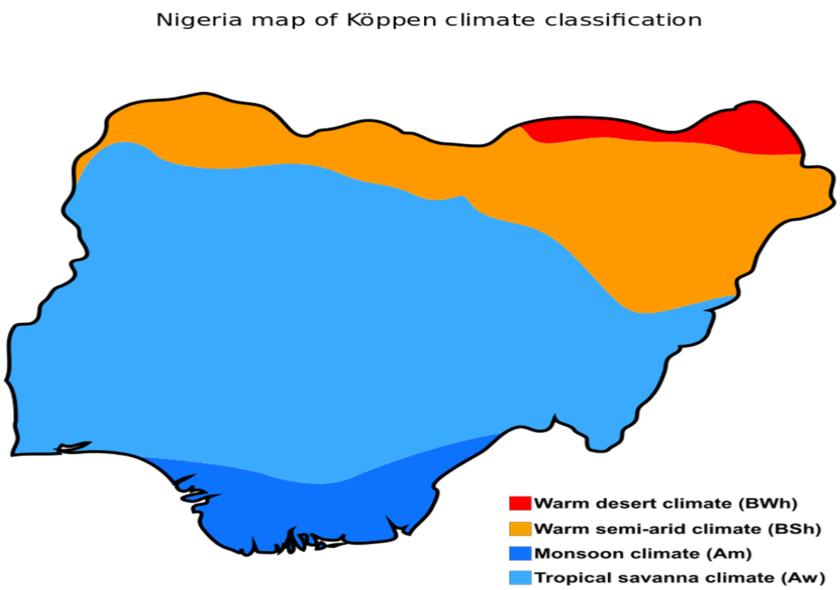

Figure 3: Map of Nigeria showing climate classification

Source: Zifan (n.d.)

(b) The low-lying nature of much of the coastal parts of Nigeria due to its natural geological setting also constitutes a natural threat to the Nigerian environment. Generally, rising to less than 5 metres above sea level, these coastal regions are highly prone to flooding even with small rises in sea level (Ngenvirons, n.d.) (see Figure 3).

(c) Nigeria lies in the middle latitudes in the Gulf of Guinea. It is therefore characterized by generally high and strong wave systems which have more destructive impacts on the shoreline and constantly causing shoreline erosion.

(d) Nigeria lies within the equatorial belt characterized by generally high torrential rainfall (Fig. 4). Annual rainfall ranges from over 3000mm along the coastline to about 600mm in the extreme north(Ngenvirons, n.d.). Even with its short season, rainfall in the north is usually characterized by heavy downpour and high impact torrents, contributing largely to gully erosion.

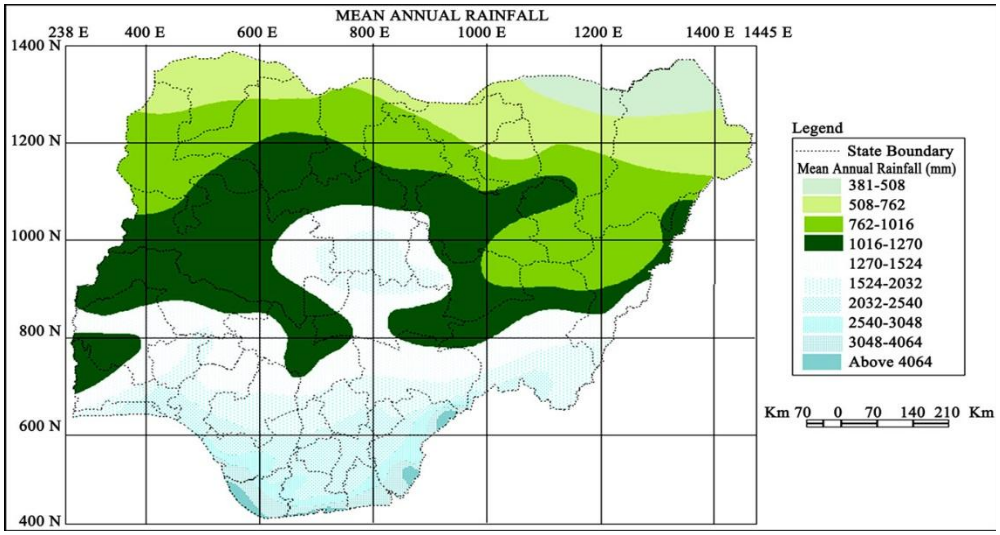

Figure 4: Map of Nigeria showing annual rainfall

Source: Ishaku and RafeeMajid (2010).

(e) Over 40% of Nigeria's land area is covered by loose Cretaceous Sandstones and deeply weathered Basement Complex rocks giving relatively soft and loose sections near surface (Ngenvirons, n.d.). Such profiles are highly susceptible to gully erosion, especially when combined with torrential rainfall.

Soils

Soil types in Nigeria are influenced by and follow very broadly, the climatic and vegetational zones of the country. This is expected because the degree of available moisture in the soil is an important factor in soil reactions and fertility and productivity (see Figure 5 for soil fertility of Nigeria: pH water). The soils of the humid tropical forests are quite different from those of the drier forests and the savanna zone, which in turn are different from the savanna zone (Aregheore, n.d.).

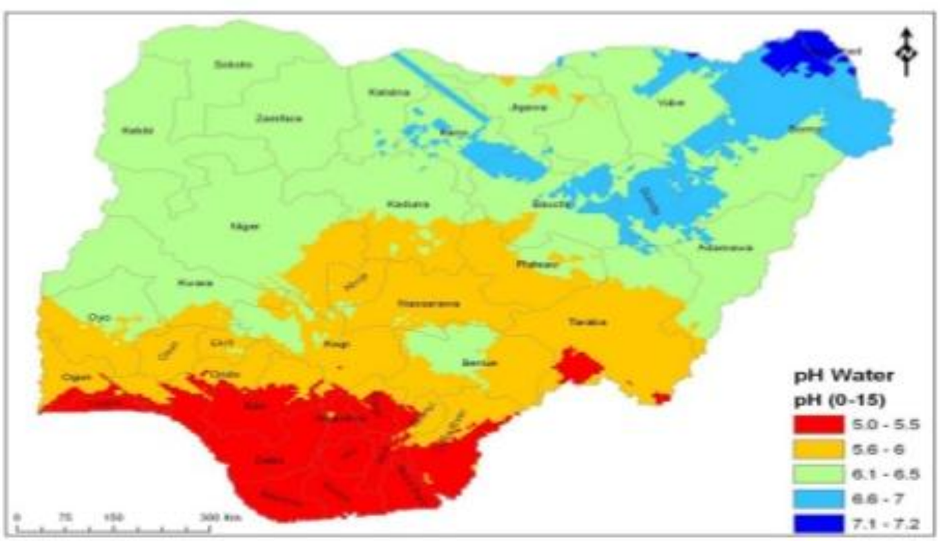

Figure 5: Soil Fertility Map of Nigeria: pH Water

Source: Google (n.d.b).

The major soil types in Nigeria, according to FAO soil taxonomy legends are fluvisols, regosols, gleysols, acrisols, ferrasols, alisols, lixisols, cambisols, luvisols, nitosols, arenosols and vertisols. These soil types vary in their potential for agricultural use (see Table 2).

None of the soils were rated as Class 1 with high productivity by the FAO. In-short over 48 % of the Nigerian soils fall into class 4 and 5, which are mainly vertisols, alisols, acrisols, ferrasols and arensol. These soils usually have low productivity due to inadequate moisture retention capacity and low organic matter. Except for the ferrasols, they are the most dominant types found in the northern dry parts of the country.

Table 2: Productivity potential of Nigerian soils

Soil Productivity grade	FAO Productivity Classes	Area	
		km^2	% of total
High (1)		-	-
Good (2)	Fluvisols, Gleysols, Regosols	50.4	5.52
Medium (3)	Lixisols, Cambisols, Luvisols, Nitosols	423.6	46.45
Low (4)	Acrisols, Ferrasols, Alisols, Vertisols	289.2	31.72
Low (5)	Arenosols, Nitosols	148.8	16.32

Source: Adegbola, S.A. (1979).

2.1. Prosopis Africana in Nigeria

Prosopis Africana is a multipurpose tree of great economic value among the rural communities in the Guinea savanna of Nigeria (Agboola, 2004). The tree is generally known as Iron wood Tree in Nigeria and itbelongs to the family Minosoceae. It is variously called; Kiriya (Hausa), Ayan (Yoruba), Ubwa (Igbo) and Gbaaye or Kpaaye (Tiv). This list of names is however in-exhaustive, because in North-Central Nigeria the Iron wood tree is widely known and called differently by the many different ethnicities in the region.

The species is widely distributed in the Sahel region of Africa and is native to Africa; occurring from Senegal to Ethiopia throughout the Sudananian and Guinea eco-zones. It is a common deciduous savannah tree throughout West Africa. Like the African Locust bean tree; the Iron wood tree is widely distributed in Nigeria; a common characteristic distribution on farm-lands in North-central states of Nigeria namely Benue, Jos, Kaduna, Kogi, Kwara and Nasarawa States. However, their population in the wild is now threatened because of extended uses and particularly, of its wood for fuelwood and burnt bricks production (Tee et al., 2009).

The fruit of the tree is used as feed for animals, while the seeds are fermented to make ukpehe, a highly proteinaceous condiment. The tree is not cultivated. The products from the hard wood, such as some wooden farm implements, kitchen utensils, and planks for construction, are extensively traded. The tree is a good source of firewood and charcoal. The secondary roots are used as medicine (Agboola, 2004). In summary, Iron wood tree is widely utilized in Nigeria and other African countries for consumption, source of income/employment as well as ecological services.

2.2. Cow Dung

Cow dung, also known as cow pats, cow pies or cow manure, is the waste productof bovine animal species. These species include domestic cattle ("cows"), bison("buffalo"), yak, and water buffalo. Cow dung is the undigested residue of plant matter which has passed through the animal's gut. The resultant faecal matter is rich in minerals. Color ranges from greenish to blackish, often darkening soon after exposure to air (Wikipedia, n.d.). Cow dung, which is usually a dark brown color (usually combined with soiled bedding and urine) is often used as manure (agricultural fertilizer). If not recycled into the soil by species such as earthworms and dung beetles, cow dung can dry out and remain on the pasture, creating an area of grazing land which is unpalatable to livestock.

In many parts of the developing world, and in the past in mountain regions of Europe, caked and dried cow dung is used as fuel. Dung may also be collected and used to produce biogas to generate electricity and heat. The gas is rich in methane and is used in rural areas of India and Pakistan and elsewhere to provide a renewable and stable source of electricity (Denmark, n.d.).

In central Africa, Maasai villages have burned cow dung inside to repel mosquitos. In cold places, cow dung is used to line the walls of rustic houses as a cheap thermal insulator. Most of villagers in India spray fresh cow dung mixed with water in front of the houses to repel insects. It is also dried into cake like shapes and used as replacement for firewood (Wikipedia, n.d.). In Nigeria, traditionally, cow dung is used as a fertiliser, though today dung is collected and used to produce biogas (Essiet, 2015).

3. Literature Review: Composting

A review of literature has revealed a wide variation in compost quality and characteristics. Dresbøll and Thorup-Kristensen (2005) investigated the physical properties of produced compost and the process parameters of composting based on plant residue feedstock from three different species of plants (wheat, hemp, and miscanthus). The authors indicated that different plant feedstocks changed the texture of the compost produced noticeably, affecting parameters like water retention, particle size distribution, C/N ratio, and the amount of mineralized nitrogen.

Physical and chemical properties of commercial compost based on their feedstocks and location of origin were investigated by Zmora-Nahum *et al*. (2007). The authors found that while the compost properties differed widely, there was significant correlation of properties based on the type feedstock.

Microbes are major drivers of the composting process, and as such, characterization and identification of microorganisms in compost is important to better understand degradation mechanisms. Microbial community structures change during the composting process as temperature and chemical conditions change. Blanc *et al*. (1999) classified the microbial variety in composts using a combination of population counts and rDNA isolate tests. The authors reported that thermophilic bacteria were being replaced with less thermophilic bacteria as the temperature in the compost pile dropped below optimal ranges for thermophilic bacteria (Blanc *et al.*, 1999).

Fernandez *et al*.(2008) have evaluated carbon degradation value during co-composting of exhausted grape marc with different biowastes: manure and straw, municipal solid waste and grape straw. They concluded that co-composting of exhausted grape marc not only enhanced the carbon degradation rate, but also reduced the carbon remnant fraction at the end of the composting process (Fernandez *et al.,* 2008).

Tognetti*et al*., (2005) applied co-composting when mixing municipal organic waste with biosolids and the result showed that this led to improved organic matter concentration therefore enhancing the compost quality and market value while creating products that improve the nutritional capacity of the soil (Tognetti*et al*., 2005).

The chemical and physical stability of the compost determines the shelf-life and applicability of compost for various uses. A stable compost is one that shows an advanced degree of organic matter decomposition with resistance to further decomposition (Mondini*et al*., 2003; Wichuk and McCartney, 2010). A stable compost shows steady values of a number of indices like respiration rates (Wu *et al.*, 2000), microbial count and biomass, organic matter content, C/N ratio, and storage temperature (Baffi *et al*., 2007; Wichuk and McCartney, 2010).

Many phytotoxins, which are compounds detrimental to plant growth, come from agricultural use of pesticides, industrial solvents, propellants, and refrigerants (e.g., halogenated alkanes, alkenes, and aromatic (aryl) hydrocarbons), degradation of waste plastics (polymers, pigments, bulking agents, and filler materials), and storm water runoff. Composting facilitates microbial degradation of organic molecules with phytotoxic properties, and in addition, organic matter generated through composting can bind phytotoxic metals and thereby reduce their bioavailability. Direct germination rates, or a modified germination index (comparison of germination rates of a test vs a control growth media) have been used as indicators of phytotoxicity in composts (Pascual*et al.,* 1997; Tiquia *et al.*, 1997; Tiquia and Tam, 1998; Tiquia and Tam, 2000; Wu *et al.*, 2000; Tang *et al.,* 2006; Himanen and Hänninen, 2011).

4. Materials and Methods

Prosopis Africana fruits were collected from Ilorin, Kwara state in the north central zone of Nigeria. The Prosopis Africana shells were washed, dried, separated from their seeds and pulverized and stored in an airtight container at room temperature.

4.1 Preparation of Compost

Prosopis Africana was washed, dried and crushed. Prosopis Africana shells were pulverized and separated from its seeds, 50g was weighed into a conical flask and 10g of cow dung and added to it in the flask. 60ml of distilled water was added and all the components of the flask were thoroughly stirred together. It was covered with foil paper and kept at room temperature for decomposition. Samplings were carried out on a weekly basis for seven weeks (7, 14, 21, 28, 35, 42 and 49 days)to monitor the decomposition in terms of loss in weight, change in moisture content, electrical conductivity, pH and temperature. The weight was measured using a weighing balance in order to determine the decomposition. The pH, electrical conductivity and temperature were measured by preparing 1% $^{wt}/_{wt}$of compost in water and then oven dried in the oven after each sampling. After each sampling day, the content of the flask were oven dried at 100^{o}C for about 30 minutes and a control sample was prepared without cow dung amendment. 1% $^{w}/_{w}$ of the sample was taken at every 7 days interval. The electrical conductivity was measured using EC214 conductivity meter and pH was measured using Inolab 7310 pH meter. The temperature, conductivity and weight of the selected sample was recorded before being oven dried. The weight after oven drying was also recorded so that the discrepancy after oven-drying would correspond to the moisture content.

Temperature, one of the key indicators of composting determines the rate of many biological processes as it indicates the end of the transition from the active phase to the curing phase. This plays a selective role on evolution and succession of microbiological communities (Hassen et al., 2001). In the study, the temperature measurements were taken from the compost during the whole period of decompostion . The results from the table gives a graph of the variation of those parameters measured during the period of decompostion.

5. Results and Discussions

5.1 Presentation of Results

The temperature, electrical conductivity, moisture content, loss in weight and pH for the composting experiment is presented generally in Table 3. However, the breakdown and dicussion of results were done subsequent tables.

Table 3: Loss in weight, moisture content, pH, electrical conductivity and temperature of composting experiment.

SN	Composting Period (Days)	Temperature (^{0}c)	Moisture Content	Loss In Weight (G)	Ph	Electrical Conductivity (S/M)
1	7	30.50	150.78	2.47	9.67	117.23
2	14	30.33	161.60	2.49	8.67	105.7
3	21	30.67	148.94	2.34	7.87	93.26
4	28	30.67	150.49	2.40	7.70	97.43
5	35	29.33	154.67	2.65	8.20	64.17
6	42	29.17	144.88	2.66	9.00	46.23
7	49	30.00	158.46	2.84	9.20	36.30

Source: Field report

5.2.1 Temperature

Table 4: Temperature (^{0}C) against composting period (days).

S/N	Composting period (days)	Temperature (^{0}C)
1.	7	30.50
2.	14	30.33
3.	21	30.67
4.	28	30.67
5.	35	29.33
6.	42	29.17
7.	49	30.00

Source: Field report

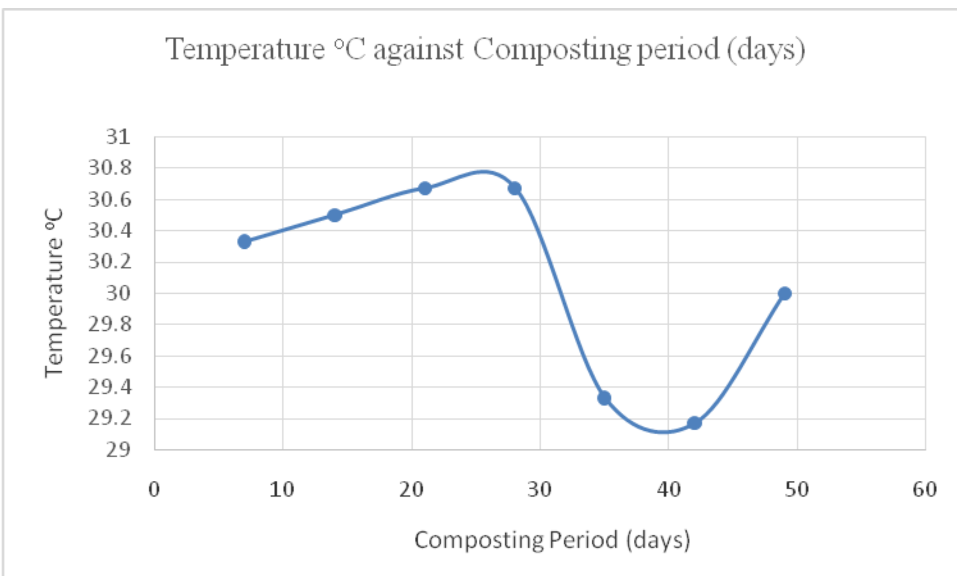

Figure 6: Graph of temperature against the composting period.

Source: Field report

Figure 6 explains the relationship of the temperature with the composting period (days) during composting. Temperature range in this study falls within the acceptable range for composting of organic material. The decomposition of the Prosopis Africana was rapid in the first week of the composting process resulting in increase in temperature of the compost due to the heat liberated by the action of microorganisms that degrade the compost using the surrounding oxygen (Ros *et al.*, 2006). This may be referred to as the active phase of the composting process.

The temperature was maintained at about 30°C for a minimum of 14 days to destroy the viability of many pathogens in the mixture. A pathogen is an organism that produces a disease. An example of a very well known pathogenic bacteria is Salmonella. There are some 200 immunologically distinguishable types of Salmonella known to be pathogenic to humans. But there are many more that infect animals, including livestock. Cross-infection between people can occur via water pollution. The spreading of untreated or poorly treated compost on land and its use for the irrigation of crops can also be a source of infection (Lenntech, n.d.). However, the temperature of the compost was monitored such that it does not produce so much heat that the compost burst into flame. The second stage; the curing phase, is evident in the graph where the graph steeps down significantly, this occurs during the fourth week. This indicates the lowering of temperature (i.e., dropping to ambient air temperature) when the decomposition is almost over and mesophilic microorganism recolonize the compost. The last phase where the temperature dropped is the maturation phase which is characterized by decrease in temperature (Bernal et al., 2009). Mature compost is a stable material with content called humus that is dark brown or black and has a soil-like, earthy smell (EPA, n.d.). Compost application can improve soil quality and productivity as well as sustainability of agricultural production by replenishing soil organic matter and supplying nutrients (Duong, 2013).

Agriculture is the backbone of the economic system of a given country. In addition to providing food and raw material, agriculture also provides employment opportunities to very large percentage of the population (Agriculture Goods, n.d.). That is why **a**griculture has been regarded in recent times as the most viable route with which Nigeria can successfully meander from her current economic dilemma (Aikhionbare, 2016).

5.2.2 Loss in Weight

Table 7:Loss in weight(g) against composting period(days)

S/N	Composting Period (Days)	Loss In Weight (G)
1.	7	2.47
2.	14	2.49
3.	21	2.34
4.	28	2.40
5.	35	2.65
6.	42	2.66
7.	49	2.84

Source: Field report

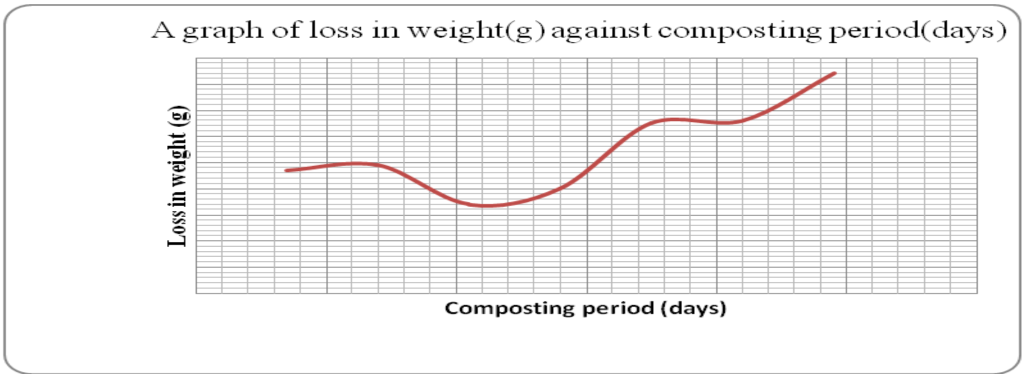

Figure 8: A graph of loss in weight against composting period

Source: Field report

The profile for weight loss was found to drastically increase generally throughout the composting period due to the volatilization losses of nitrogen in the compost (see Figure 8). These gaseous losses can include NH_3, N_2O, N_2, and possibly other nitrogen oxide compounds (Martins and Dewes, 1992; Körner et al.,1999). Volatilization losses of nitrogen vary depending on the balance with available carbon (Martins and Dewes, 1992; Rynk et al.,1992) and with oxygenation level (Michel and Reddy, 1998). Loss of nitrogen can also result from high ammonium levels at high pH. Concerning the effect of these gaseous losses on the environment, Hao and Benke (2008) observed that the biggest challenge in composting is N loss, mainly as NH_3 and to a lesser extent as N_2O. Ammonia contributes to smog formation and reduces air quality. Near large feedlot operations, high atmospheric NH3 depositions have been linked to plant diversity decline, soil acidification and surface water eutrohication. Emission of N_2O (greenhouse gas) contributes to global warming and climate change (Hao and Benke, 2008). Scientists and economists are beginning to grapple with the serious economic and environmental consequences if greenhouse gases emission is not quickly and deeply reduced (UCS, n.d.). As Forbes (2017) observed, global warming affects the geography within which the global economy operates. It changes growth zones. It changes shorelines. It changes the places where humans will feel comfortable living. In addition, if humans actually decide to do anything about it, it will change the way industry and people use fossil fuels.

5.2.3 Electrical Conductivity

Table 9: Values for electrical conductivities (S/m)

S/N	Composting Period (Days)	Electrical Conductivity (S/M)
1.	7	117.23
2.	14	105.7
3.	21	93.26
4.	28	97.43
5.	35	64.17
6.	42	46.23
7.	49	36.30

Source: Field report

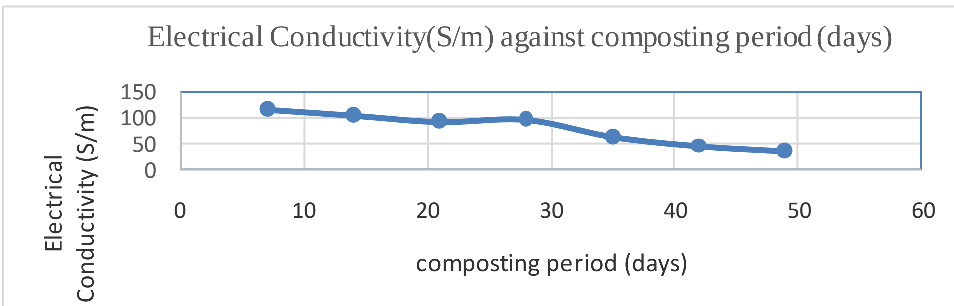

Figure 10: Electrical conductivity (S/m) against composting period (days)

Source: Field report

The highest conductivity was measured at the initial time of decomposition. This graph shows a negative slope which indicates that the amount of free ions in a solution decreases with increasing composting period. The electrical conductivity is actually a measure of salinity. Compost with excessively high salinity can affect plants in the following ways: Specific toxicity of a particular ion (such as Sodium); Higher osmotic pressure around the roots prevents an efficient water absorption by the plant. Some plants are more susceptible to the electrical conductivity than others and each specie has an electrical conductivity threshold, beyond which yield is decreased (Sela, 2017).

4.2.3 Moisture Content

Table 10: The values for the moisture content during the composting period

S/N	Composting Period (Days)	Moisture Content
1.	7	150.78
2.	14	161.60
3.	21	148.94
4.	28	150.49
5.	35	154.67
6.	42	144.88
7.	49	158.46

Source: Field report

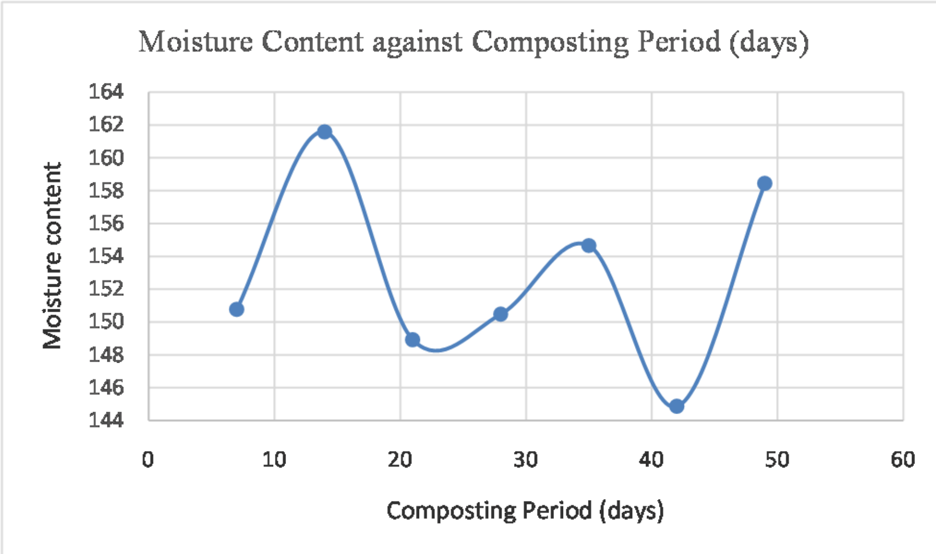

Figure 11: The graph of moisture content against composting period
Source: Field report

The result of this study reveals that the moisture content varies significantly with the temperature profile. Moisture content are important parameters to evaluate maturity of compost (Ameen et al., 2016). Rynk (2000), Haug (1993), Lin et al. (2008), Kuwahara et al (2009) and Nakayama et al (2007) suggested that the optimal moisture content for biological activity is between approximately 40 and 60 percent of the compost's weight. Rynk (2000) also mentioned that the critical moisture content range for supporting spontaneous combustion is around 20 to 45 percent; above this range there is moisture sufficient for the evaporation process to cool the temperature and below it there is insufficient moisture to sustain the biological reaction. Normally, the composting process operates with a moisture content range of between 40 and 70 percent (Haug, 1993). The graph in figure 11 shows that the moisture content increases from the first week as the active phase of the composting process progresses rapidly, the moisture content also decreases during the curing phase according to the graph. The reduction in the value of moisture content at the end of composting is a positive sign of decomposition and it gives mature compost (Epstein et al., 1995).

4.2.4. PH

Table 11: pH versus Composting period (days).

S/N	Composting period (Days)	PH
1.	7	9.67
2.	14	8.67
3.	21	7.87
4.	28	7.70
5.	35	8.20
6.	42	9.00
7.	49	9.20

Source: Field report

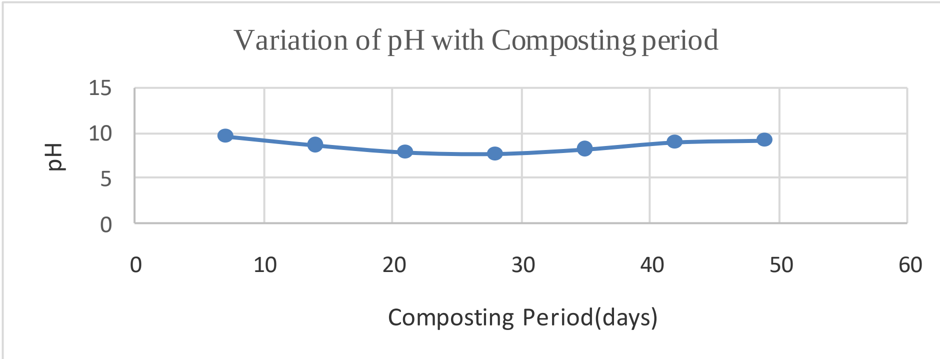

Figure 12: A graph showing the relationship between pH and the composting period.
Source: Field report

As shown in figure 12, the pH initially decreases for the first three weeks. During the process of co-composting, the pH value for the compost tended to stabilize at around 7.79 and 8.10. This slight decrease in pH was noted in the compost and can be explained by the production of organic acids; dissolved CO_2 in the medium and by-products from the degradation of easily degradable compounds such as polysaccharides and fats. Also, a lack of oxygen that can occur between two turnings can result in the production of acids (Kochtitzky*et al.*,1969; Mustin ,1987; Peters *et al.*,2000).

In terms of environment and pH, soil pH affects the amount of nutrients and chemicals that are soluble in soil water, and therefore the amount of nutrients available to plants. Some nutrients are more available under acid conditions while others are more available under alkaline conditions. However, most mineral nutrients are readily available to plants when soil pH is near neutral. The development of strongly acidic soils (less than 5.5 pH) can result in poor plant growth as a result of one or more of the following factors: aluminum toxicity, manganese toxicity, calcium deficiency, magnesium deficiency, low levels of essential plant nutrients such as phosphorus and molybdenum. Alkaline soils may have problems with deficiencies of nutrients such as zinc, copper, boron and manganese. Soils with an extremely alkaline pH (greater than 9) are likely to have high levels of sodium (Greensland Government, n.d.).

5. Conclusion and Suggestions During Future Research

Economic activity is spurred by production which uses natural resources, labor, and capital. It has changed over time due to technology (automation, accelerator of process, reduction of cost functions), innovation (new products, services, processes, new markets, expands markets, diversification of markets, niche markets, increases revenue functions) such as, that which produces intellectual property and changes in industrial relations (Wikipedia, n.d.c). However,wastes are generated by activities in all economic sectors involving loss of materials and energy, and imposes economic and environmental costs on society for its collection, treatment and disposal (Morselli et al., 2008). Composting is a biological conversion of heterogeneous organic substrate under controlled conditions, into a hygienic, humus rich and relatively bio-stable product that conditions soil and nourishes plants (Kalaiselvi and Ramasamy, 1996). Composting has a great importance in economic terms, because it affects a lot and directly into increased productivity culture for which it is used. However, making and using of compost should not be detrimental or dangerous for the environment. The natural environment is an important component of the economic system, and without the natural environment the economic system will not be able to function.

This study has attempted to probe the physical and chemical transformations that occurred during the 49-day composting of Prosopis Africana shell and cow dung and implication on environment. However, for future research, firstly, the variation of the C/N nitrogen during the composting period should be monitored and recorded weekly. Secondly, the composting process is an aerobic process and therefore needs adequate supply of oxygen, the use of foil paper to cover the conical flask should be discouraged. Thirdly, graph showing moisture content during the composting period showed that the moisture content did not stabilize at any point, probably implying that the composting of Prosopis Africana shell should take a little longer than 49days before compost maturity is properly reached.

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