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Full Length Research Paper

Economics of Bio-based Fertilizers in Promoting Organic Farming in Northwestern Nigeria

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This paper assessed the role of bio-based fertilizers in promoting organic farming in Northwestern Nigeria Agriculture is the main source of soil degradation processes. Therefore, soil improvement is an important task. The possibilities for using composted either municipal waste or residues from biogas production for soil improvement is inevitable. The advantages and disadvantages should be analyzed and discussed. The composition, production techniques, usefulness and constraints of bio-based fertilizers were analyzed. At present these options are not yet feasible in the North because of the high prices of anaerobic digestion plant and the insufficient quantities of plant residues and animal manure. Advantages of waste processing are multiple as it produces compost of organic origin and can be used as a soil improver to recover nutrients and improve structure. The findings showed that Organic fertilizers increases the growth, yield and quality of crops as well as soil properties through extension education. Production and use of organic based fertilizers help to convert wastes which would otherwise become a nuisance to the environment to environmentally friendly and agriculturally useful materials. The use of extension workers to enlighten farmers on how best to handle organic based fertilizers contributes immensely in improving crop production in tropical environment. The research work was done using different materials such as neem seeds, calcium carbonate, bone mill, blood mill, rice husk and potash. The production of the fertilizer was done by mixing the materials and taken to the hammer mill for milling. Finally, the milled fertilizer was taken to the granulator for granulation and later dried off and packaged. The chemical analysis of the finished product was carried out by different methods; Nitrogen (N) was analyzed by kjelahl method, Phosphorus (P) by brary & kurtz no.1 method, potassium (k) flame photometric method and organic carbon (c) by walkeley-black method. The result of the analysis showed that Nitrogen (N) 0.672%, Phosphorous (P) 5.17 mg/kg, Potassium (K) 11.50 mg/kg, and Organic Carbon (C) 3.890.

Keywords: Assessment, Role, organic farming, Bio-Based Fertilizer, Northwest Nigeria.

INTRODUCTION

Organic farming is on the increase as a result of the activities of organic bodies like National Organization of Organic Agriculture Network (NOAN). Organic Agriculture Project in Tertiary Institutions in Nigeria (OAPTIN) and West African Network of Organic Agriculture (WANOART) with improved awareness of organic agriculture in the country, organic agriculture is now being practiced at a large scale level in Nigeria

(Olowokere2005).Commercial production of organic based fertilizers becomes relevant under large scale farming because the time required for preparation of these fertilizers will be reduced if they can be purchased in large quantity and such times could be used for other activities on the farm. Some of the commercial organic based fertilizers are produced to be crop specific, i. e. the specific nutrients required by a particular crop would have been included in the course of preparation. Materials with additional properties could also be included in the fertilizers. Therefore, it is necessary to compare the efficiency of some of the commercially produced fertilizers in Nigeria (Mustapha et. al, 2011).

Bio-fertilizers are substance which contains living micro-organisms which, when applied to seeds, plant surfaces, or soil, colonize the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances. The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of bio-fertilizers, healthy plants can be grown, while enhancing the sustainability and the health of the soil. Bio-fertilizers can be expected to reduce the use of synthetic fertilizers and pesticides, but they are not yet able to replace their use. Since they play several roles, a preferred scientific term for such beneficial bacteria is "plant-growth promoting (Tewari, 1992).

Generally, the fame of this ‘wonder tree’ neem in the production of bio-based fertilizers spread to western countries and after a lot of researches funded by internationally acclaimed organizations like UN, neem and its products were accepted for their therapeutic value and having no side effects in US, UK, Australia among others. Neem tree has miraculous powers and scientists are beginning to unfold the powers and potential of this revealed tree. It is now being cultivated and grown in a number of countries to fully tap its potential and used on a commercial basis(Aganon, *et al* 2004).Neem cake is a bio-fertilizer that can be used for organic farms, agriculture, gardens and lawns. Neem cake is obtained from neem seed kernel and consists of natural micro-nutrients with NPK. Neem cake organic fertilizer (manure) is the bye product obtained in the process of neem oil extraction from neem seeds through oil expellers or solvent extraction process. Neem cake organic fertilizer is traditionally being used in India as manure for soil application, since more than 5 decades, especially in southern states like Karnataka, Tamil Nadu and Kerala. Neem cake organic fertilizer contains organic nutrients like Nitrogen, Phosphorous, Potassium, Calcium, Magnesium etc. It is a proven soil conditioner and it is being used directly or in blends with other manure like Urea, farmyard manure etc., for its benefits of organic nutrients, pest repellant properties and its control on soil bound nematodes (Tewari, 1992).According to research calculations, neem cake seems to make soil more fertile due to an ingredient that block soil bacteria from converting nitrogenous compounds into nitrogen gas. It is a nitrification inhibitor and prolongs the availability of nitrogen to both short duration and long duration crops (Puri, 1990).Neem-based organic fertilizer has many advantages among which include: Minimizes the requirement of nitrogen in crop production and hence reduces the cost of fertilizer, Increases crop yield substantially and very cost effective, Increases the efficiency of nitrogenous fertilizer use, and better yield than conventional urea and fertilizer Protects plant roots from nematodes, soil grubs and improve soil organic content, In comparison to urea which is a nutrient collector, neem cake itself contains nutrient for plants, Can be used with other fertilizer / urea simultaneously, It contains 100% natural NPK content. (Anis Joseph *et al.,* 2010; Vethanayagam, and Rajendran, 2010)

Study Area

Description of Northwestern Nigeria

Northern Nigeria was an autonomous division within Nigeria, distinctly different from the southern part of the country, with independent customs, foreign relations and security structures. In 1962 it acquired the territory of the British Northern Cameroons, which voted to become a province within Northern Nigeria. In 1967, Northern Nigeria was divided into the North-Eastern State, North-Western State, Kano State, Kaduna State, Kwara State, and the Benue-Plateau State, each with its own Governor

The great savannah belt of the Great Plains of Hausa land dominates much of the rest of the province. This region experiences rainfall between 20 and 60 inches (508 and 1,524 mm) per year. The savannah zone's three categories are Guinean forest-savanna mosaic, Sudan savannah, and Sahel savannah. Guinean forest-savanna mosaic is plains of tall grass which are interrupted by trees. Sudan savannah is similar but with shorter grasses and shorter trees. Sahel savannah consists of patches of grass and sand, found in the northeast. In the Sahel region, rain is less than 20 inches (508 mm) per year and the Sahara Desert is encroaching. In the dry north-east corner of the country lies Lake Chad, which Northern Nigeria shares with Niger, Chad and Cameroon (Ibrahim, 2003) Northern Nigeria was divided into thirteen provinces: Bauchi, Benue, Borno, Kano, Katsina, Plateau,

Sardauna, Niger, Adamawa, Zaria, Sokoto, Kabba and Ilorin.

Kano, the largest of the provinces in terms of population and economy, is in the North-Central part of the country. The Kano Native Authority, an offshoot of the fula Kano Emirate, inherited the ancient trade industries that fuelled the trans-Saharan trade with North Africa. The Province of Zaria is home to the City of Kaduna, an autonomous capital city that serves as the nation's capital and home to its national institutions (Ibrahim,2003).

Groundnut and cotton industries in the province of Kano provided the main source of revenue for Northern Nigeria. Tin mining in the Province of Plateau, Steel mining in the Province of Benue, and other metal industries in the Province of Sokoto, built up the diverse mining industry of the region.

Cement industries in Sokoto and Bauchi and leather processing industries in Kano constituted the main manufacturing sector.

Northern Nigeria though an ethnically and religiously diverse region, is an overwhelmingly majority Muslim region. The Hausa and Fulani dominate much of the North Western and eastern part of the Country. The Hausa, Fulani are chiefly Muslims. A small part of the Hausa population also adheres to the ancient religion of Hausa Animism. The Nupes and the Kanuri are also chiefly Muslims. Small Christian populations also exist in the north. They were converted to Christianity after the colonization of the country by the British (Ibrahim, 2003).

Objectives of the study

The main aim of this paper is to assess the usefulness of bio-based fertilizer in improving organic farming through agricultural extension education. Specifically, the objectives include:

1. To assess the efficacy of bio-based fertilizers in enhancing organic farming through extension education in tropical environment.
2. To explore the ways of producing bio-based fertilizers and determine the efficiency with which organic fertilizers generates major nutrients for improved crop production in the tropics
3. To analyze the chemical composition of the organic fertilizer
4. Analyze the constraints of Bio-based Fertilizers

Chemical Composition of Bio-based Fertilizers

Bio-based fertilizers are composed of the following percentage components as plant nutrients. The final product is compost, an organic fertilizer of about 36% water, and 30-38% organic substance in dry mass. Its quality depends on its nutrient contents nitrogen (N) - phosphorus (P) potassium (K), as well as the content of metals and organic toxic substances. When organic compost is added to the soil, this will improve the soil quality and structure and will finally result in higher yield. Composting of municipal sol can recycle nutrients. Its safe use in agriculture, however, depends on the production of good quality compost, specifically, compost that is mature and sufficiently low in metals and salt content. The content of N, P, K and organic C, as w the pH and the presence of toxic heavy metals arsenic (As), cadmium (Cd), zinc Zn, lead (Pb) and cuprum (Cu) are analyzed in the accredited Laboratory for analysis of the components of the environment, part of the Executive Agency on Environment. These parameters are important for determination of the quality of compost and the composting installations are regularly subjected to analyses of these components.

Table showing the Composition and available Plant Nutrients in Bio-basedfertilizers

Nutrient	Formula	**Percentage Composition**
Nitrogen	N	1.5 – 3.0 %
Nitrogen	P	1.0 – 2.0 %
Phosphorus	K	1.0 – 2.0 %
Calcium	Ca	0.5 – 1.5 %
Magnesium	Mg	0.3 – 1.5 %
Sulphur	S	1.0 – 3.0 %
Zink	Zn	15 – 60 ppm
Copper	Cu	4.0 – 20 ppm
Iron	Fe	500 – 1200 ppm
Manganese	Mn	20 – 60 pmm

Source: www.saosis.com/products/neem**cake**

Benefits and Efficacy of bio-based fertilizers in enhancing organic farming

1. Bio-fertilizers are means of fixing the nutrient availability in the soil. Generally Nitrogen deficiencies.
2. Since a bio-fertilizer is technically living, it can symbiotically associate with plant roots. Involved microorganisms could readily and safely convert complex organic material into simple compounds, so that they are easily taken up by the plants. Microorganism function is in long duration, causing improvement of the soil fertility. It maintains the natural habitat of the soil. It increases crop yield by 20-30%, replaces chemical nitrogen and phosphorus by 30%, and stimulates plant growth. It can also provide protection against drought and some soil-borne diseases.
3. It has also been shown that to produce a larger quantity of crops, bio-fertilizers with the ability of nitrogen fixation and phosphorus solubilizing would lead to the greatest possible effect.
4. They advance shoot and root growth of many crops versus control groups. This can be important when implementing new seed growth.
5. Bio-fertilizers also promote healthy soil, leading to greater farming sustainability.

Neem and its parts are being used to manufacture urea coating agent to improve and maintain the fertility of soil. The fertility of the soil can be measured by the amount of Nitrogen, Potassium and Phosphorous it has; there are certain bacteria found in soil, which denitrify it. Use of neem urea coating agent helps to retard the activity and growth of the bacteria responsible for denitrification. It prevents the loss of urea in the soil. It can also be used to control a large number of pests such as caterpillars, beetles, leafhoppers, borer, mites etc. Urea coating is generally available either in liquid form or powdered form. Properties of Neem Urea Coating are Anti-feedant, anti-fertility and pest growth regulator (Subbalakshmi 2012) Neem tree has been used against household, storage pests and crop pests. Neem pest fumigant is available in gaseous state and is used as a pesticide and disinfectant. It is being used by a large number of countries on a commercial basis by farmers and agriculturists. This 100% natural product is being exported as it is nontoxic and does not affect the environment. It assumes more importance in developing countries where millions of deaths are reported every year due to the accidental intake of synthetic pest fumigants (Subbalakshmi, *et al* 2012).

Constraints of Bio-based Fertilizers

Improper organic waste disposal poses a major threat to the environment and high risks to human health this therefore requires educating the farmers by extension agents on how best organic wastes could be handled. Most of these wastes are biodegradable and can be converted into valuable resource that reduces their otherwise negative impacts. The conversion of these waste materials to valuable resources can be observed in the production of organic fertilizer and its subsequent utilization as a source of plant nutrients in intensive small-scale organic-based production and for sustaining soil health and productivity. Extension education an promote proper waste management by the society via organic fertilizer production and demonstration of the feasibility of growing plants using organic fertilizer as the major source of plant nutrients.

MATERIALS AND METHOD

Table 1: List of Materials Used

Materials	Source
Neem seeds	Zuru
Rice husk	Technology incubation center (TIC) B/K
Poultry litters	Diggi Village
Bone mill	Technology incubation center (TIC) B/K
Blood mill	Technology incubation center (TIC) B/K
Potash	Technology incubation center (TIC) B/KCalcium
carbonate (CaCO3)	Sokoto Cement, Sokoto
Gum Arabic	Tambuwal

Table 2: List of Instruments/Equipment used

Instruments	Source
Weighing Balance (analogue)	Technology Incubation Center (TIC) B/K
Shovel	Technology Incubation Center (TIC) B/K
Bucket	Technology Incubation Center (TIC) B/K
Hammer mill	Technology Incubation Center (TIC) B/K
Granulator	Danyaro Investments Ltd, Sokoto

Ways of Producing Bio-based Fertilizers

Production of Bio-based fertilizers through agricultural Wastes

Wood ash has useful properties for fertilization, as a strong alkali. It is a neutralizing agent for acidic soils. Wood ash, apart from nitrogen, contains the nutrients, especially phosphorus that plants need for growth. Application of wood ash to fertilize peatland forests seems to be a promising and cost-effective method of waste management after wood combustion (Väätäinen et al., 2011). Co-granulation of plant ash with sewage sludge is a fertilizer containing all the nutrients that plants need, including nitrogen. Co-incineration of fossil fuels and biomass can prevent the use in fertilization due to the presence of many undesirable substances, like an excessive content of heavy metals in fly ashes made from fossil fuels. Agricultural waste can also be used as a source of biodegradable polymers such as polylactic acid (PLA). Various PLA bio-composites have also been tested with other wastes, including celery root fibers and pomace (Spiridon et al., 2018). Agricultural residues with low water content (cereal straw, maize stalks) are a useful combustion input.

Global annual production of nitrogen from animal manure is 100 Tg N. 60–80% of this amount is dissipated into the environment; the rest is recovered and used as fertilizer (Oenema et al., 2007). Livestock manure (mostly from pigs, cattle, and poultry) is a resource of organic material and useful microorganisms, which is an unexploited source of N fertilizer, also improving the soil properties and crop yields.

Poultry litter is a waste in poultry farms contains, apart from the excrement, also feathers and residues of spilled animal feed (Turan, 2008). Due to the dynamic development of the poultry sector, the amount of waste is rapidly increasing and needs to be managed. The poultry litter contains many valuable macro and microelements, which after pre-processing (due to the odor and presence of pathogens) can be used in agriculture. For the processing of poultry litter for fertilizer production, biological and thermal methods are proposed, of which thermal methods seem to be worth considering on a larger scale (Ma and You, 2019). Similarly, manure from pigs and cattle husbandry is the source of many valuable ingredients that can be recovered, e.g. through microbiological methods.

Production of Bio-based fertilizers through Food waste

The production of food waste in Northern Nigeria is on average 95–115kg/year per person. Annually 1.3 billion Mg of food is wasted in the world, which is approximately one-third of the edibles produced globally (Gustavsson, 2011). Food waste includes residues from households and restaurants, waste streams from processing, and crop cultivation residues (Du et al., 2018). Such waste contains carbohydrates (starch, cellulose, and hemicelluloses), proteins, lignin, fat and a high amount of moisture (Uçkun Kiran et al., 2014).

Prevention of food loss and waste – through theoretically well discussed – has been implemented by 20% of the 50 largest global food companies. The losses occur mainly at cultivation and consumption, around 30% on the stage of food supply chain.

Biofertilizers can be produced from food waste by anaerobic digestion, aerobic composting, and chemical hydrolysis; various agricultural wastes (i.e. wheat straw) can be directly returned to soil (Du et al., 2018). Spent coffee grounds could be valorized through appropriate management (i.e. composting, anaerobic digestion, and pyrolysis) and reused, bringing valuable products for agriculture and improving soil structure and fertility (Stylianou et al., 2018).

Assessment of properties of fertilizers from bio-resources

Large amounts of generated waste are a continuous source of important components. Waste containing valuable materials, going to landfill, mixed up, is an irreparable loss to the industry while being a significant burden to the environment. Since waste biomass is varied, it must be processed with different methods (Cobo et al., 2018). Waste ought to be collected selectively for appropriate fractions and biodegradable groups, starting with households, which is necessary to manage waste in terms of valorization. This will enable its proper management to obtain energy or materials, including good quality fertilizers. In the elaboration of new fertilizers, it is important to investigate in real system (on the field) their effect on soil quality and crop yield (Sigurnjak et al., 2016). When developing a new fertilizer technology through valorization of waste, it is important to maintain the balance of nutrients, economic and environmental assessment. Crop yield and soil quality should be considered, similarly as NPK use efficiency and compared with the commercial reference products. The performance of fertilizers can be investigated by chemical soil analysis, plant response to fertilizer determination and P-fractionation – P-release patterns (Vaneeckhaute et al., 2016). The large scale of fertilizer production facilities is a barrier to the implementation of technologies that use a renewable raw material base. Hence, there is a demand for a large amount of raw material that is repeatable and qualitatively standardized. Therefore some additional factors are required to convince farmers to use fertilizers produced from the renewable resource base, such as national policies, subsidies, creating infrastructure for collection, handling, storage, distribution and sanitation (Wang et al., 2018).

RESULTS

Table 3: Showing the Chemical Analysis

Nutrients	Symbol	Standard	Compositions of fertilizer
Nitrogen	N	1.5-3.0%	0.672%
Phosphorous	P	1.0-2.0%	5.17mg/kg
Potassium	K	1.0-2.0%	11.50mg/kg
Carbon	C		3.890%

DISCUSSION

Considering the large volume of wastes generated in the world and the fact that 60% is biodegradable, an information campaign is needed by extension agents so as to enlighten farmers on the segregation of wastes at source, waste classification and waste recycling which should be intensively carried out through frequent group discussion. In the production of bio-based fertilizers, segregated wastes collected from neem tree were brought to the material recovery facility (MRF) and were used as the substrate for organic fertilizer production. The production of organic fertilizer from solid waste (neem seeds) composed of assembly area, composting area, drying area, and storage area. Substrates used as compost materials included the neem seed, lime stone, potash, blood meal, bone meal, chicken manure as microbial activators, and carbonized rice hull as a stabilizer.

The nutrients in the fertilizer were Nitrogen (N) 0.672% which is in agreement with saosis work on plant nutrient in neem fertilizer (2005), Phosphorous (P)

5.17mg/kg which is also in agreement with Nenita (2011), production of organic fertilizer from solid waste and its utilization and Potassium (K) 11.50mg/kg which is in agreement with the research work of Mustapha et al (2012), the need for organic farming in extension. The results of table 3.1 is comparatively in agreement with the work of Ayeni et al (2012), comparative effect of organic fertilizer and IFOAM (1999) basic standard for production and processing of organic waste and their effects. Nitrogen (N) is necessary for lush, green, leafy growth. An excess, however, will promote vegetative growth at the expense of fruits or flowers. Nitrogen is generally applied at higher concentrations in early growth stages. Phosphorous (P) is necessary for big, bright blooms and enhance fruit production. It is essential for fruiting, flowering, strong root growth and quality seed development. Potassium (K) helps produce strong sturdy plant and quality fruits. It's naturally increases a plant resistance to all types of stress and is vital for cell growth and carbohydrate metabolism.

CONCLUSION/ RECOMMENDATIONS

This paper serves as a hands-on training venue for organic fertilizer production not only for for farmers but also for outside clients. Extension education will enormously assist farmers to be aware of the ways of converting solid wastes into organic fertilizer which will not only increase farm and household income but also become a stable source of organic fertilizer for rehabilitating highly nutrient depleted agricultural soils and reduce environmental pollution generated by improper waste disposal. The conversion of solid wastes into a valuable resource such as organic compost or organic fertilizer is a worthwhile strategy for saving the Earth from further degradation generated by improper waste disposal and management. Moreover, the continuous use of organic fertilizer as a source of plant nutrients for agricultural production not only reduces the cost of fertilizer but serves as the ultimate solution for restoring the lost fertility of agricultural soils as well as soil health; this leads to sustained soil productivity. Production of organic fertilizer from solid wastes and its subsequent utilization in crop production and soil rehabilitation is therefore recommended through extension intervention so as to reduce the volume of wastes that are brought to dumpsites, minimize environmental pollution and degradation and increase the productivity of cereal and other crops in the tropical environment. Heavy application of inorganic fertilizers resulting from acute lack of contact with extension officers has polluted surfaces and groundwater resources, therefore, the use of organic based fertilizers which is ecofriendly is recommended.

It is recommended that solid waste composting for the production of organic fertilizer should be disseminated to people by extension agents in order to solve waste disposal problems through conversion of biodegradable wastes into organic compost; this will ensure the availability of organic fertilizer forcrop production in the tropics and the world at large.

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