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EVALUATION ON THE EFFECT OF COST EFFECTIVE COW DUNG (IN BIO-FERTLIZERS FORM) ON THE GROWTH AND YIELD OF MAIZE (ZEA MAYS) PRODUCTION IN THE NIGER DELTA AREA (BAYELSA STATE) OF NIGERIA

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ABSTRACT: *Evaluation on the effect of cost effective cow dung in bio-fertilizer form on growth and yield of Maize (Zea mays) production in the Niger Delta Area, was conducted, in 2017 cropping season of Bayelsa State, at the Niger Delta University Teaching and Research Farm, Wilberforce Island, Bayelsa State, Nigeria, located within latitude 5^0N and longitude 6.05^0E of the equator. Treatments adopted for the experiment was cow dung in bio-fertilizer form, which was applied with different rates 0, 5, 10, 15, and 20 t/ha, and replicated 5 times, experiment was laid out in a Randomized Complete Block Design (RCBD). The least significant difference (LSD) was used to compare the means at 5% level of significance. Parameters assessed were growth and yield components of maize which included plant height, leaf area, cob length and girth, average number of kernels per cob, weight of 1000 kernels and yield in t/ha. Parameters, generally, increased significantly with an increase in the rate of application of cow dung on the experimental plots. The result obtained from the yield (t/ha) showed that, there was no significant differences between the application rates of 20, 15, 10 and 5 t/ha of cow dung, whereas only at 20 t/ha differed significantly when compared to the untreated (Control), but 20t/ha, had more yield than the rest rates of application. However, twenty (20 t/ha) application rate of cow dung bio-fertilizer produced the highest yield with a mean value of 6.45 t/ha when compared to the control (0 t/ha) which had the least mean yield value of 4.05 t/ha. Furthermore, the control had the lowest mean values in all the growth and yield parameters tested throughout the period of assessment, whereas application rate of 20t/ha produced the highest mean values and differed significantly from the rest application rates of cow dung in all of the growth parameters of maize of production. Therefore, 20t/ha of cow dung was recommended for small scale farmers in the study area and other parts of the Bayelsa State and the Global World which had similar soil characteristics and environmental conditions, that are found in the arable area of land for maize production. In fact, this research work has created positive awareness to the people of Niger Delta Area on the danger of inorganic fertilizer application in our soils, because they are hazardous to the ecosystem that affected the biodiversity of some beneficiary soil microbes, because the type of maize farmers in the area which had little or no adequate knowledge on the negative chemical residual impact of inorganic fertilizer, to our crops and the soil microbes, which affected the biodiversity of some beneficiary soil microbes, hence the evaluation on this research project work to create the awareness on the importance of cow dung bio-fertilizer that are readily available in our environment at the Niger Delta Area of Nigeria.*

KEYWORD; Cow dung. Bio-fertilizers**,** Niger Delta, parameters, growth and yield components, plant height, leaf area, cob length and girth, average number of kernels per cob, weight of 1000 kernels, tonnes, hectare.

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Maize (*Zea mays* L) is an important cereal crop in the Tropics and Sub Tropical areas in the Global World. It is an important crop in West Africa, because of its numerous importance on nutritional values and industrial usage. Maize is produced on about 60 million hectares with an average yield of 1.2 tonnes per hectare at the Global World; it is rated as the most important cereal fodder and grain crop under both irrigation and rain fed agricultural systems in the semi-arid and arid tropics and ranks among the most widely grown and used crop in the world (Asadu and Igboka, 2014). Maize provides invaluable roughages for dairy and beef cattle and constitutes a high proportion of concentrate in livestock feeds as reported by (Ogundare, *et al*., 2016); all the vegetative parts of maize: the stalks, leaves, grains and immature ears are used as livestock feeds and human beings as food, the grains of maize are rich in vitamin A, C, E, carbohydrate, dietary fiber and calories which are good sources of energy for human and livestock (Damiyal, *et al*., 2017).

Maize production in Nigeria has been militated by a number of factors that are against maize production, with soil infertility problems as the chief principal factor. Measures to mitigate these factors prior to now have been adopted such as bush fallowing, this practice however, is no longer in vogue considering the ever increasing geometric population of the country and high demand for maize and its by-products as well as unavailability of land which emanated from industrialization of most arable land, the practice of bush fallowing could no longer be encouraged, thus, having an adverse effect on soil fertility, because the soils are overused before allowing the cropping environment to lay fallow, thereby resulting to low yield of crops (Eifediyi and Remison, 2010). However, this problem can be relieved by employing other nutrient enriching practices such as, the use of organic manure e.g. cow dung and farmyard manure.

Livestock manure has been an asset to crop production, since the beginning of an organized agriculture. Because, these excretions from cattle contained several essential plant nutrients, they contributed to increased crop yields when properly applied to soils. Thus, dairy and other livestock producers can use manure as a valuable source of organic fertilizer nutrients for maize production. Cow dung supplies adequate organic matter for rapid crop production in order to meet the protein, carbohydrate and fat requirements of the teeming population. The organic matter improves soil tilt, aids in the retention of water and nutrients holding capacity, lessens wind and water erosion and promotes growth of beneficial microorganisms (Jodie, *et al*., 2017). This forms the brainchild behind this study, which seeks to explore and implore the use of cow dung in relation to the growth and yield of maize.

Maize production in the country particularly in the Niger Delta Area significantly had low quality, in terms of taste, weight loss and yield, when applied with inorganic fertilizers. Fertilizers are not readily available and expensive, ad also had negative impact to the soil microes, because most of the maize growers are low resource based farmers. They had no adequate knowledge on the residual effects of inorganic fertilizers to the soil, application of inorganic fertilizers was in appropriate. Hence, this study was conducted at the Niger Delta University, Teaching and Research Farm to create awareness of the danger in inorganic fertilizers in Niger Delta Soils, in the Niger Delta Area of Nigeria. About 100% of the population of Niger Delta depend on maize as staple food. Therefore, its importance needs to be protected with the application of Cow dung

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in the form of bio-fertilizers to enrich the soil microbes that are beneficiaries to prove the quality and quantity of maize production to meet the protein and carbohydrate dietary requirement to people of the Niger Area of Nigeria.

Based on these constraints, we used alternative strategies with organic manure (Cow dung) that are cost effective, eco-friendly and readily available for sustainable maize production for high yield quality, that could be used to encourage small scale farmers or low resource based farmers to adopt. Hence, this study on‘‘**Evaluation on the Effect of cost effective Cow Dung in bio-fertilizer form on the Growth and Yield of Maize (*Zea mays* L) production in the Niger Delta Area (Bayelsa State) of Nigeria**’’ was chosen.

The objectives of this study are to: investigate the effects of cow dung on the growth and yield of maize and also ascertain the optimum rate of cow dung required to enhance the performance of maize production in relation to growth and yield of maize. Maize or corn (*Zea mays* L.) originated from Central America particularly, Southern Mexico. Maize belongs to the family Poaceae. *Zea* is an ancient Greek word which means “sustaining life” and Mays is a word from *Taino* language meaning “life giver.” The word “maize” is from the Spanish connotation “*maiz*” which is the best way of describing the plant. Various other synonyms like zea, silk maize, makka, barajovar, etc. are used to recognize the plant (Kumar and Jhariya, 2013).

Taxonomy of maize;
Maize taxonomy is classified as; Kingdom: Plantae,Subkingdom: Tracheobionta Superdivision: Spermatophyta, Division: Magnoliophyta, Class: Liliopsida Subclass: Commelinidae ,Order: Cyperales, Family: Poaceae Subfamily: Panicoideae, Tribe: Andropogoneae, Genus: Zea, Species: *Zea mays*.The genus Zea consists of four (4) species of which *Zea mays* L. is economically important. The other Zea species, referred to as teosintes, are largely wild grasses native to Mexico and Central America. The number of chromosomes in *Z. mays* is 2n = 20. The tribe Andropogoneae comprises seven genera, namely old and new world groups. Old world comprises Coix (2n = 10/20), Chionachne (2n = 20), Sclerachne (2n = 20), Trilobachne (2n = 20), and Polytoca (2n = 20), and new world group has Zea and Tripsacum (Biology of maize, 2011; Shah, Prasad and Kumar, 2016).

Conditions required for maize production
The maize plant is universally referred to as a versatile plant; it is cultivated virtually in all parts of the world except Antarctica, due to the variation of maize producing region. It has very specific water and climatic requirements in order to thrive. Most importantly, for the plant to germinate, it needs a temperature ranging from 15 to 20ºC (Orhun, 2013). Maize thrives in most soils but less so on very heavy dense clay and sandy soil; but, a well, drained, sandy loam soil with a pH range of 5.7-7.5 is most suitable; with a rainfall range of 500-800mm, if grown based on rain fed agriculture and an evenly distributed water canals and channels under irrigation system throughout the growing season. Due to the shallow nature of the root system (fibrous root system without tap roots), maize plant is solely dependent on soil moisture, which is required for optimal growth and yield (Orhun, 2013).

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Maize Production
Globally, maize ranked third after wheat and rice in terms of area harvested, but in terms of annual production maize ranked first; it is the largest grown (785 million tons) cereal in the world with doubled grain yield per unit area compared to wheat and barley (Orhun, 2013). By world standard, Africa is a minor producer of maize accounting for only 7% of global production, while the average annual productions were estimated at 32 Million Metric Tonnes (MMT) during 1985-1987, which increased to 49MMT during 2005-2007. Area planted with maize in west and central Africa increased from 3.2 million in 1961 to 8.9 million in 2005 which lead to increased production from 2.4MMT in 1961 o 10.6MMT in 2005 (IITA, 2009). Until the middle of the 20th century, maize production in the Sub-Sahara Africa grew mainly through expansion in the area planted. However, shortage of the land mass has eliminated area expansion as a potential source of production growth and there is an increased attention on increasing productivity (Amudalat, 2015).

There is continuous increase in production of maize all over the world and this is attributed to both increase in area of production and increase in yield per hectare. Maize grain production in the world in 1970 was about 266 million metric tons (MMT), while in year 2000; it was over 592 MMT and exceeded 844MMT in 2010. Of the total global production, United States is far the biggest producer, contributing between 37-43% of the total world production next to China (177 MMT), Brazil (56 MMT), Mexico (23 MMT) and Argentina (21 MMT) (FAOSTAT, 2012). Maize production in United States and other developed countries of the world is highly mechanized on large scale production, where hybrid maize varieties are commonly grown with high inputs in terms of agrochemicals (Amudalat, 2015).

Maize production in Nigeria
Increase in maize production in Nigeria has been achieved greatly by expansion in arable area harvested rather than increase in yield. The area harvested increased from 2.8 million hectares in 1996 to over 3 million hectares in 2011. Of the total production (844 Million tonnes) in 2010, Nigeria the largest producer in Sub-Sahara Africa produced 7.7 million tonnes representing 0.9% of the world production. Based on production potentials, Nigeria has been divided into four groups namely: low, medium, medium to high and high maize production potential reported by (ATA, 2011). The average yield of maize in Nigeria as in other Sub-Sahara Africa countries is generally very low 1.68 tonnes/hectare, which is very low compared to the average yield of maize in United Stateths on maize production data (9.3 tonnes/ha) over the same period as stated by(Amudalat, 2015).

Cow dung
Cow dung can be defined as the undigested residue of consumed food material being excreted by herbivorous bovine animal species. Being a mixture of feces and urine as presented in the ratio of 3:1, it mainly consists of lignin, cellulose and hemicelluloses. It also contains 24 different minerals like nitrogen, potassium, along with trace amount of sulphur, iron, magnesium, copper, cobalt and manganese reported by (Gupta, *et al.*, 2016). Cow dung is an important source of nitrogen for crop production in the small scale farming or low resource based farming. It helps farmers to reduce inputs of commercial fertilizer, thereby increasing the profit margin of farmers. Nutrients

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contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect, thus supporting better root development or formation, leading to higher crop yields as revealed by (Amos, *et al*.,2015).

Cow dung Nutrient performance in soil

Nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby, ensuring a long residual effect (Kerethi, *et al*., 2014) thus, supporting better root development, leading to higher crop yields reported by (Shar, *et al*., 2009). The use of organic materials has been proposed as one of the main pillars of sustainable agriculture as they provide large amounts of macro and micro nutrients for crop growth and are eco-friendly besides being renewable alternatives to mineral fertilizers as reported by (Damiyal *et al.,* 2017).

Nutrient Values of dairy manure

Nutrient content of manure from dairy cattle is affected by a variety of factors, many of which are related to a specific farming operation. Some of these factors include method of storage, type of manure application system, housing and bedding system, diet of the cattle and environmental factors particularly temperature. All of these constraints affect the amounts of Nitrogen (N), Phosphorus (P), Potassium (K) and micronutrients in the manure, as well as its net value reported by (Jodi *et al.,* 2017). Effects of nutrient composition of manure from dairy cattle were illustrated Table 1.

Table 1: Average nutrient composition of manure from dairy cattle

	Nutrients (lbs/tonnes)		
Handling system	**N**	**P_2O_5**	**K_2O**
Solid system	11	5	11
Semi-liquid	26	11	23

(Jodi *et al.,* 2017).

Table 2: Composition and estimated uptake of nutrients by crops (per tonne dry matter of cow dung).

	Composition (% DM)		Nutrient uptake per Acre (lbs)			
Crop	Crude protein	P	K	N	P_2O_5	K_2O
Alfalfa	20.8	0.34	2.80	353	78	337
Maize	8.3	0.27	1.22	133	62	147
Sorghum	7.9	0.32	1.80	126	73	217
Rice	___	___	___	176	52	154

(Jodi *et al.,* 2017).

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Effect of cow dung on maize

Asawalam and Onwudike, (2011) reported significant differences in soil chemical properties such as: pH, organic matter, nitrogen, available phosphorus, exchangeable potassium, calcium and magnesium. They further indicated that 3.7 tonnes/ha of cow dung increased soil organic matter and phosphorus more than NPK fertilizer when compared.

Damiyal *et al.,* (2017) conducted a study on the effect of cattle manure and inorganic fertilizer on the growth and yield of hybrid maize; they investigated the effects of different levels of cattle manure (0, 5 and 10 tonnes/ha) and NPK (0, 200 and 400kg/ha) on the growth, yield and yield components of hybrid maize (*Z. mays* L.). They reported that cattle manure levels had significant effect on number of leaves per plant and plant height; significant interactions were observed in mean number of leaves, plant height, husk weight and yield (tonnes/ha) from available literatures. The highest seed yield (5.65tonnes/ha) was obtained when 5tonnes/ha cattle manure was used. Researchers, further recommended the application of 5tonnes/ha cattle manure or 400kg/ha NPK is recommended for improved production of hybrid maize in the study area.

Amos *et al.,* (2015) conducted a trial to evaluate the performance of vegetable maize using cow dung at four application rates (0, 5, 10, and 15 tonnes/ha) on three local varieties of vegetable maize, namely, Bataji, Choci and Dan-Bauchi. The result indicated that growth and yield parameters and final yields, all increased significantly ($P \leq 0.05$) with additional rates of cattle manure. Application of 15 tonnes/ha increased plant height by 24%, leaf area by 27% and fresh husked cob weight by 13% among other parameters. Irrespective of application rates, Bataji performed significantly better than Dan-Bauchi and Choci in most of the parameters with the exception of kernel density and 1000 seed weight, Choci performed significantly better than the other two varieties. The use of Bataji variety with 15 tonnes/ha was recommended for good performance of vegetable maize production.

Wisdom *et al.,* (2012) carried out a comparative study on the effect of organic manure (cow dung) and inorganic fertilizer (N.P.K) on the growth of maize (*Z. mays* L.), they indicated that maize plants treated with NPK had higher mean number of: leaves, stem diameter, shoot and root dry weight, but that the difference was not significant. However, NPK improved the height of maize plant significantly in contrast to cow dung was revealed. They recommended that cow dung manure can be used in the absence of NPK fertilizer considering the cost and associated environmental effect of the later.

Maize Nutritional Value

Maize, being popular as a food item, is enjoyed by people in various forms, like, whole corn, corn flour, corn starch, corn gluten, corn syrup, cornmeal, corn oil, popcorn, cornflakes, etc. Apart from satisfying the taste buds of its users, maize is also a good source of vitamins, minerals and dietary fiber. The nutritional value of cornflakes is almost similar to that of cooked maize. One large ear of cooked yellow maize contains almost 4 grams of protein, 3.5 grams of dietary fiber, around 30 grams of carbohydrates, 1.5 grams of fat, 3.6 grams of sugar, around 100 grams of water, no cholesterol and amounts to 126 calories. Below refers to Table 2.3 on maize nutrition facts and information about the vitamin and mineral content in one large ear of yellow maize, which is cooked without salt (MF, 2017).

Table 3: Maize nutritional information – Vitamins and minerals

Vitamin	**Amount per 100 grams**	**Mineral**	**Amount per 100 grams**
Vitamin A	310 IU	Potassium	250 mg
Vitamin B1 (thiamine)	0.254 mg	Phosphorus	90 mg
Vitamin B2 (riboflavin)	0.085 mg	Magnesium	37 mg
Vitamin B6	0.071 mg	Calcium	4 mg
Vitamin C	7.3 mg	Zinc	0.72 mg
Vitamin K	0.5 mcg	Iron	0.52 mg
Vitamin E	0.11 mg	Selenium	0.20 mg
Niacin	1.9 mg	Copper	0.40 mg
Folate	54 mcg		
Pantothenic Acid	1.036 mg		

Source: MF, (2017); Shah *et al.*, (2015)

Benefits of Maize

Maize is the most important raw material for industrial starch has been revealed by researchers from available literature cited. Maize starch is a maize product and it is employed in the manufacture, ceramics, dyes, plastics, oil cloth, paper and paper boards and in textiles, cosmetics, and pharmaceutical industries. The derivatives of maize starch include glucose or corn syrup, corn sugar, dextrins and industrial alcohol, which are employed in different industries (Orhun, 2013). Meal is a primary product obtained from maize. The meal from maize can be obtained by manual or mechanically milling. The other products include: tortillas, maize flours, chips and several types of snack, breakfast cereal, thickness, pastes, syrups, sweeteners, grits, maize oil, soft drinks, beer, whisky (Orhun, 2013).

The composition of maize endows it with many health benefits. The high fiber content prevents constipation and colorectal cancer.Antioxidants neutralize the effects of harmful free radicals that cause diseases like cancer. The antioxidant betacryptoxanthin prevents lung cancer, while lutein prevents age related vision loss. Antioxidants slow cognitive decline and conditions like Alzheimer's. Vitamin C boosts immunity and fights infections, while the presence of vitamin E gives maize anti-aging properties.Thiamine is required for boosting memory, cognitive functions and nerve health, and pantothenic acid is essential for energy, as it is linked to carbohydrate, protein and lipid metabolism. Folate is an essential requirement, especially during pregnancy.The phosphorus helps to maintain normal growth, kidney function and bone health. Magnesium boosts the latter, as well as regulates the heart rate. Finally, maize lowers LDL cholesterol and guards against cardiac diseases, diabetes and hypertension.

The traditional maize, like other cereals, also provides proteins, lipids and little water. Maize has also diuretic properties when taken as a tea and is a component in certain oils, corn oil and syrup. One of the nutritional benefits of maize comes from its rich carbohydrate that is derived from its abundant starch.

Maize has various health benefits. The B-complex vitamins in maize are good for skin, hair, heart, brain, and proper digestion. They also prevent the symptoms of rheumatism, because they are believed to improve the joint motility. The presence of vitamins A, C, and K together with beta-carotene and selenium helps to improve the functioning of thyroid gland and immune system for human and livestock. Potassium is a major nutrient present in maize which has diuretic properties. Maize silk has many benefits associated with it. In many countries of the world such as India, China, Spain, France and Greece, it is used to treat kidney stones, urinary tract infections, jaundice, and fluid retention. It also has a potential to improve blood pressure, support liver functioning, and protect bile. It acts as a good emollient for wounds, swelling, and ulcers. Decoction of silk, roots, and leaves are used for bladder problems, nausea, and vomiting, while decoction of cob is used for stomach complaints as revealed by (Kumar and Jhariya, 2013). The nutritional benefits of maize are also determined by its vitamin A, which functions as an antioxidant in preventing diseases such as cancer.

The high fiber content is another characteristic linked to the nutritional benefits of maize. This condition makes it suitable for diets that are made to lose weight and those made with the aim of lowering cholesterol levels.Recently clinical studies in Japan, published in the Journal Biochemical and Biophysical Research Communications, have shown that purple corn (*Z. mays* L.) could be a great ally in the fight against diabetes and obesity as reported by (MF, 2017).

MATERIALS AND METHODS

Description of Experimental Site

Field experiment was conducted at the Niger Delta University Teaching and Research Farm, Faculty of Agriculture, Wilberforce Island Bayelsa State. To determine the efficacy of Cow dung on the quality and quantity of maize production. The experimental site is located within Latitude 5^{o}N and Longitude 6.05^{o}E of the equator (Alagoa, 1999) at the Niger Delta Area of Nigeria. The experiment was conducted during the 2017 cropping season in a typical humid environment.

Topography of Experimental Area

The area was characterized with a bimodal rainfall pattern with peaks in June and September and an interrupted dry spell in August (August-break). The topography is gently undulating with pockets of hills. Land use in the experimental area is typically based on rain-fed agriculture with root tubers and vegetables as prominently cultivated crops, the vegetation is a rainforest.

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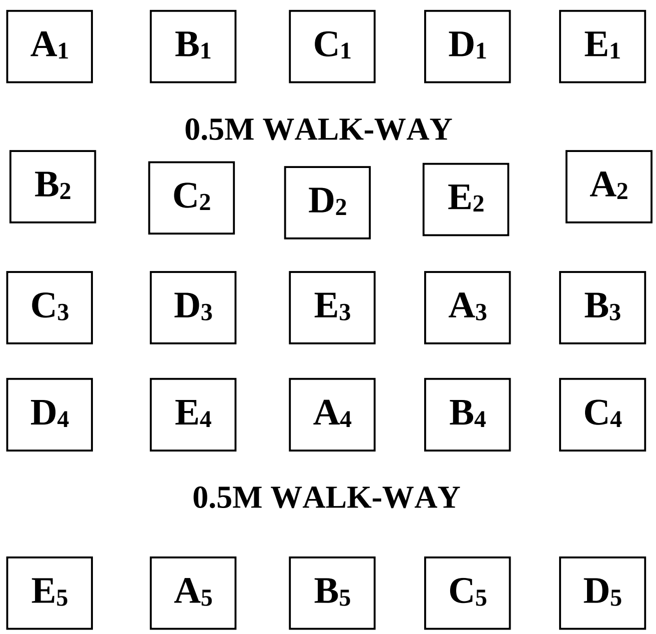
Experimental Design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four treatments and a control (0, 5, 10, 15 and 20 t/ha) all replicated five times to give a total of 25 plots.

Field Activities

Land measuring 625m^2 (25 m X 25 m) was selected and mapped out using pegs and twine. The vegetation was manually cleared, gathered and removed using cutlass and rake thereby exposing the soil. The sub-plots were marked out according to the experimental layout into 25 plots, each measuring (5.0m X 2.5m). Alley pathways (walk-ways) of 0.5m were made vertically and horizontally for easy access to the plots. The soil was manually tilled per plot, using hoe and was later pulverized with a smaller hand hoe to make soil level smooth and suitable for easy germination and establishment of crops upon growth according to the practical orientation of (Hamma *et al.*, 2012).



Source; Field Survey, 2016.

Figure 3.1: Schematic representation of Experimental plots

Treatments

The following treatments were evaluated in this study, such as;

A = 5 tonnes/ha of cow dung, B = 10 tonnes/ha of cow dung
C = 15 tonnes/ha of cow dung, D = 20 tonnes/ha of cow dung
E = 0 tonne/ha of cow dung (control)

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METHOD OF APPLICATION OF TREATMENTS

Treatment using the different rates of (cow dung) were applied to the soil two weeks before planting in order to enable proper decomposition and release of nutrients that would serve as starter dose for the crop (Hamma *et al*., 2012). Slurry were made from the cow dung at different rates which were thoroughly mixed and stirred with 10 liters of water; the volume of water increased by 5 liters as the quantity of cow dung increased by 5tonnes/ha and were applied with watering can to each plot according to the treatments to ensure the release of nutrients embedded in the cow dung and to aid even distribution. Afterwards, it was incorporated into the experimental plots at the stipulated rates of: 5, 10, 15, and 20 tonnes/ha.

Planting

Maize seeds (Flint corn) were obtained from a vendor of the Agritropic Limited, in Amassoma. The seeds were sown on the 8th of December, 2017 in the plots at the rate of two seeds per stand, spaced at (0.7 m X 0.3 m), at a planting depth of 2.5 cm. Each of the plots had 95 stands, a total of 2375 stands. The seedlings were later thinned down to one plant per stand, giving a population of 47619 plants/ha.

Field Maintenance

Routine maintenance practices such as thinning and supplying of missing stands were carried out at 2 weeks after planting (WAP), weeding along the base and walkway was done at 2, 4, 6 and 8 weeks after planting (WAP) as a result of excessive weed growth. Individual stands were earthed up to prevent the roots from exposure and logging as a result of heavy rainfall and wind to aid rigorous growth.

Data Collection

Ten (10) stands from each of the sub-plots were randomly selected and used as sample population on which data collection were based upon. Data collected were vegetative parameters which includes: plant height (cm), leaf area (cm); yield components which includes: cob length (cm), cob girth (cm), average number of kernels per cob, weight of 1000 kernels (kg) total yield (tonnes/ha).

Vegetative parameters were ascertained at maturity while yie components were obtained after harvest upon the dryness of the ear of maize plant.

Plant height was measured using a five meters (5m) pole from the base of the plant to the highest of the flag leaf; leaf area was calculated using the formula (L x B x Coefficient) where L (length in cm) and B (breadth in cm) were measured using a measuring tape and coefficient is a standard value of 0.75cm.

Cob girth and length were obtained using Vernier Calipers; **weight of 1000 kernels** was determined using electronic weighing scale while total yield per plot was obtained using a 10kg measuring scale.

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Statistical Analysis
Data collected were subjected to Analysis of Variance (ANOVA), and means from respective treatments were separated using Least Significant Difference (LSD) at 5% significance level of probability ($P < 0.05$). To establish any significant differences between treatments applied; statistical tool (charts) were used to represent the results in other to draw healthy conclusions which will aid reliable recommendations.

RESULTS AND DISCUSSIONS

Vegetative characteristics of maize

Effects of cow dung on plant height (cm) and leaf area (cm)
The response of cow dung on plant height and leaf area of maize is shown in Fig.1. ANOVA indicated less significant treatment effect on vegetative parameters evaluated with an increased in the rate of application of cow dung on plant height. Twenty (20) tonnes/ha of cow dung recorded the highest mean value of plant height (188.68) followed by 15 t/ha treatment (168.96), next to 10 t/ha treatment of cow dung with (154.54) then 5 t/ha treatment with a mean value (144.96) and lastly the control (133.96) respectively. However, 20 t/ha application rate of cow dung significantly differed from 15, 10, 5 t/ha of cow dung and the control respectively. Similarly, plots treated with 15 t/ha of cow dung manure differed significantly from plots that received 10 and 5 t/ha of cow dung. In the same vein, 10 t/ha treatment slightly differed from 5 t/ha treated plots, which also had less significant treatment effect when compared to the control.
LSD value of plant height slightly had significant treatment effect.

ANOVA revealed significant treatment effect on leaf area shown on Fig.1. At the application rate of 20t/ha of cow dung, recorded the highest mean value of leaf area (299.30cm^2) which was followed by 15t/ha (262.70cm^2), next to 10t/ha application rate with (262.10cm^2) and then followed by 5t/ha (246.4cm^2) and finally the untreated plots (0 t/ha) with a mean value of 232.6cm^2. Presented in Fig.1 below is a bar chart showing the plant height (cm) and leaf area (cm^2) of maize as influenced by cow dung applied at the following rates (0, 5, 10, 15 and 20 t/ha), alongside their respective least significant difference (LSD) values at 5% level of significance.

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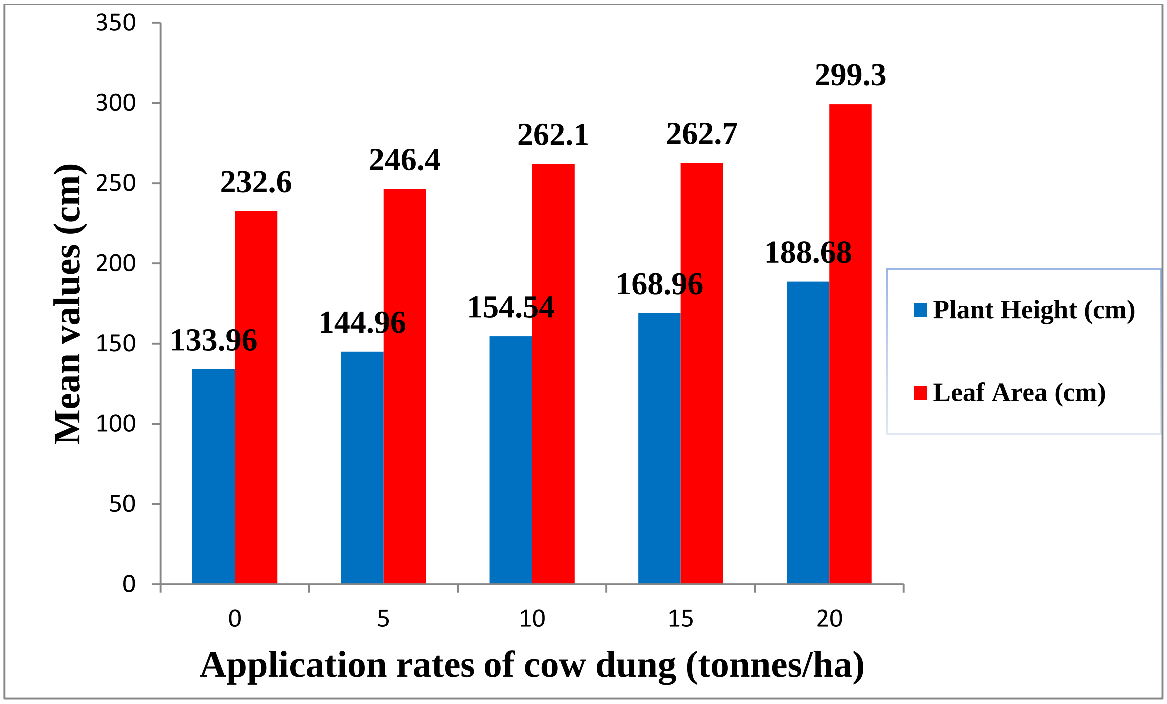

Fig.1. Effects of cow dung on plant height and leaf area of maize
LSD: Plant Height = 8.80; Leaf Area = 12.38

Effects of cow dung on cob length and cob girth (cm)

The influence of cow dung on cob length and girth of maize is depicted in Fig. 2. below. The results displayed shows that both characteristics examined increased with an increase in application rate.

ANOVA analysis revealed a highly significant treatment effect of cow dung on cob length with the different treatment rates of 20t/ha, 15t/ha and 10 t/ha when compared to the control. Twenty (20) t/ha of cow dung application recorded the highest mean value of cob length (15.51cm) which differed significantly from 15 t/ha with (13.64cm), 10 t/ha which had (13.75 cm), 5 t/ha with (12.38cm) and the control respectively. Treatments with 15, 10 and 5 t/ha of cow dung recorded differences with 10 t/ha taking the lead, followed by 15 t/ha then 5 t/ha.. Similarly, treatments with 5 t/ha of cow dung was not significantly different from the control at 5% level of significance.

ANOVA indicated that cob girth of maize as influenced by cow dung at 20 t/ha of application had the highest mean value of cob girth (13.65cm) which differed significantly from 15 t/ha of cow dung applicationwith (11.94cm), 10 t/ha which had (10.81cm), 5 t/ha that recorded (9.15cm) when compared with the control (7.77cm) respectively. Treated plots of cow dung that received 15 and 10 t/ha of cow dung were not significantly different from each other, though there were numerical differences; but however, they both differed significantly from those of 5 t/ha and the control respectively. In the same vein, treated plots with 5 t/ha differed significantly from the control at 5% significance level.

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In both characteristics examined under this subsection, the results showed that the treatments were effective when compared to the control. Presented in Fig. 2. below is a bar chart showing the cob length and girth (cm) of maize which was influenced by cow dung applied at the following rates (0, 5, 10, 15 and 20 t/ha), alongside their respective least significant difference (LSD) values at 5% Probability level (P < 0.05).

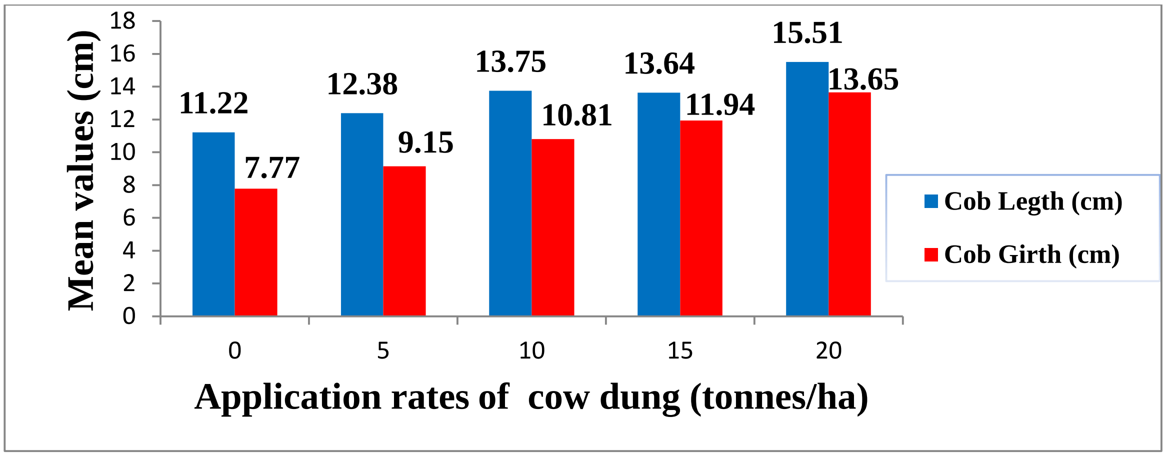

Fig. 2. Effects of Cob Length and Cob Girth of maize.
LSD: Cob Length = 1.70; Cob Girth = 1.41

Effects of cow dung on average number of kernels per cob and weight of 1000 kernels (grams)
The effect of cow dung on number of kernels per cob and weight of 1000 kernels (grams) is shown in Fig.3. ANOVA analysis indicated that there was significant treatment effect on the number of kernels per cob and weight of 1000 kernel. It was revealed that cow dung increased number of kernels in a cob and weight of 1000 kernels. On the characteristic of average number of kernels in a cob, the results indicated that 20 tonnes/ha treatment rate induced the highest number of kernels (223.00) and differed significantly from 15 t/ha that had (176.00) kernels followed by 10 t/ha with (158.00) next to 5 t/ha and lastly the control plots that recorded (110.00). Fifteen (15) t/ha treatments, on the other hand significantly differed from 5 t/ha and the control but did not differ significantly from 10 t/ha treatments. LSD value revealed that treatment rate at 10 t/ha was not significantly different from 5 t/ha in spite of numerical difference but differed significantly from the control. In the same vein, treatment plots with 5 t/ha of cow dung was not significantly different from the control on this characteristic at 5% level of significance.

ANOVA analysis indicated the influence of cow dung treatment effect on the characteristic of weight of 1000 kernels, the result revealed that treatments with 20 t/ha of cow dung were superior in mean values (185.35g) and differed significantly from 15 t/ha that had (183.82g) followed by 10 t/ha treatment rate with (161.54g) next to 5 t/ha (153.25g) and then the control (135.37g). Similarly, 15 t/ha treatment differed significantly from those of 10, 5 t/ha and the control. LSD value indicated that plots with 10 and 5t/ha had no significantly difference; while 10 t/ha differed significantly from the control but 5 t/ha treatment did not differ significantly from the control at 5% level of significance. The treatment applied on the characteristics of average number of kernels

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and weight of 1000 kernels (g) was effective as most of the application rates differed significantly from the control.

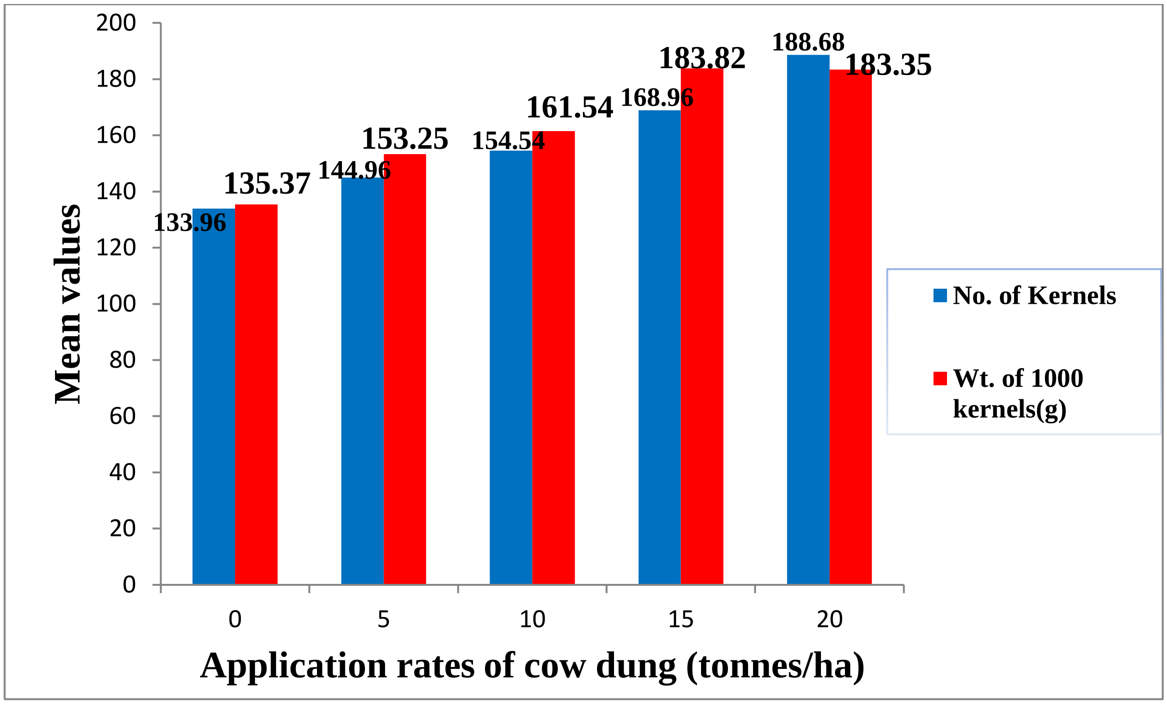

Fig. 3. Effects of Cow dung on No. Kernels per cob and Weight 1000 kernels (g). LSD: No. of kernels = 36.87; Wt. of 1000 kernels = 20.58

Effect of cow dung on maize yield (tonnes/ha)

The influence of cow dung on maize yield (tonnes/ha) was illustrated in Fig. 4. ANOVA indicated that the rate of cow dung application, had a great significant impact, on maize yield (tonnes/ha), when compared to untreated. Maize plots treated with 20 tonnes/ha recorded the highest mean value yield (6.45 t/ha) closely followed by 10 t/ha treatment with mean value of (5.62 t/ha) next to 15 t/ha treatments that had (5.60 t/ha), followed by 5t/ha which had (4.87 t/ha) and lastly, the untreated plots (control) which had (4.05 t/ha) respectively.

Noteworthy, 20 t/ha application rate of cow dung spurred yield (t/ha) however, when compared to other treatments by way of significance, Least Significant Difference (LSD) revealed that it only differed significantly from the control. These implies that treatment 20, 10, 15 and 5 t/ha are not significantly different from each other. On the other hand, treatments of 10, 15, 5 t/ha and the control were not significantly different from each other, when compared at 5% level of significance. The differences observed in this characteristics were numerical. Presented in Fig. 4 is a bar chart showing the mean yield (t/ha) of maize as influenced by cow dung as well as the LSD value. 20 t/ha application rate was outstanding and differed significantly from the control only and so did the other application rate.

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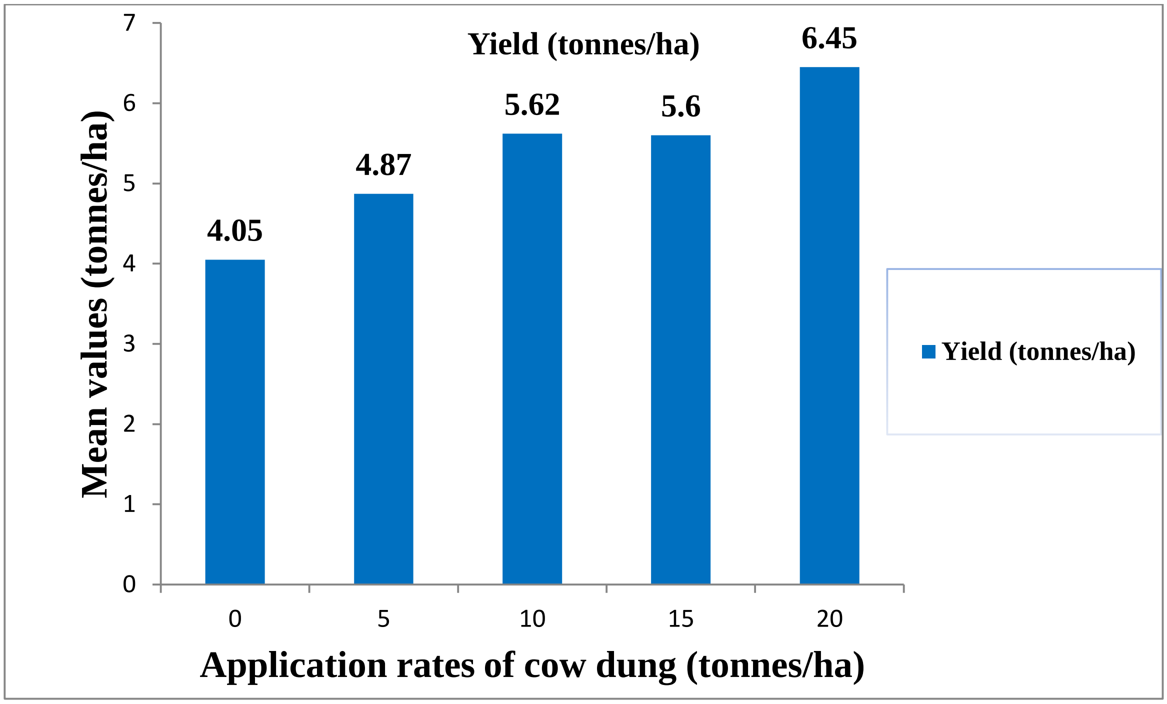

Fig. 4. Effects of different rates of cow dung application on maize yield (tonnes/ha). LSD = 1.68

DISCUSSIONS

The results of this study showed that there was significant differences in the vegetative parameters that were ascertained in this work; plant height and leaf area (cm) as well as yield parameters such as; cob length and girth (cm), average number of kernels/cob, weight of 1000 kernels (grams) and yield (tonnes/ha).

Effect of cow dung on the growth of plant height and leaf area (cm)] of maize

The findings of this research work was obtained, from the data generated, shows that cow dung significantly influenced the plant height and leaf area of maize as plots treated with 20 t/ha, had the highest mean value of plant height and leaf area values next to plots with 15 t/ha, 10 t/ha, 5 t/ha and the control plots, when compared. The findings of this study on the growth characteristics is in line with the report of (Wisdom *et al.*, 2012) who stated in his work that cow dung significantly increased plant height, stem diameter and number of leaves of maize as against the control. This significantly increased the growth parameters as influenced by increase in rate of application of cow dung, which could be attributed to plant nutrients present in cow dung, because, high yielding maize require large quantities of soil nutrients, which cow dung provides sufficiently especially the chief nutrients referred to as major nutrients: Nitrogen, Phosphorus and Potassium (Jodi *et al.*, 2017). However, the findings of this study on the characteristic of plant height was not in consonance with that of Damiyal *et al.*, (2017) who in their work on the effect of cattle manure and inorganic fertilizer on the growth and yield of hybrid maize adopted the use of 5 and 10

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tonnes/ha of cow dung; they reported that cow dung was not significant in terms of increase in height of maize.

Similarly, as in the same vein with plant height, leaf area of maize was also influenced by an increase in rate of application of cow dung. This could also be attributed to readily available nutrient provided by cow dung, all through the period of experimentation. The control plots in both parameters assessed recorded the least mean values; this might be attributed to the fertility status of the soil which lacked adequate nutrients to boost the growth of maize. This is in line with the assertion of Okoroafor *et al.,* (2013) who stated that low soil fertility is one of the limiting factors in maize production.

Effect of cow dung on yield parameters of maize

From the findings of the study, it was revealed that cow dung significantly increased yield characteristics observed with an increase in rate of application, such as: cob length and girth (cm), average number of kernels per cob, weight of 1000 kernels (grams) and yield (t/ha). On the characteristic of length and girth of maize cob, it was revealed that the rates of application significantly differed from the control and when compared to each other, 20 t/ha treatments were superior followed by 15, 10 and 5 t/ha. This can be attributed to the ability of cow dung to continually provide nutrients required for optimum yield of maize throughout its cycle. On the characteristic of number of kernels per cob and weight of 1000 kernels (gram), the result has it that an increase in application rate of cow dung will result to a significant increase in number of kernels and weight of kernels. This is in harmony with the findings of Damiyal *et al.*, (2017) who reported that 5 and 10 t/ha of cow dung incited significant increases in number of kernels and weight of kernels.

From results obtained in this study in yield (t/ha) indicates that cow dung significantly increased the yield of maize. It was revealed that in spite of the differences recorded by the rates of application (20, 15, 10 and 5 t/ha and the control) adopted for the study only 20 t/ha differed significantly from the control; however, 20, 15, 10 and 5 t/ha of cow dung were not significantly different from each other. However, the findings of this study on yield in t/ha was not in harmony with that of Damiyal *et al.*, (2017) who reported that 5 t/ha of cow dung significantly increased the yield of maize in contrast to 10 t/ha and the control. However, in this recent study, it was 20 t/ha treatment that differed significantly from the control. This can be attributed to the poor state of the soil in terms of available nutrients which required bulk quantity of cow dung to enforce significant difference when compared to the control. Also, the terrain of the experimental site allowed water to log on the soil surface thereby chocking up maize plants as some stands were missing and could not germinate even after been supplied subsequently. Another factor that militated against yield (t/ha) of this study was logging of maize stems as a result of high wind, this resulted to breakage of stem and loss of plant. Yet again, the impact of human pests in the form of poachers affected the yield of this study at the experimental site of Niger Delta University Teaching and Research Farm.

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SUMMARY CONCLUSION AND RECOMMENDATION

Summary

This study was carried out to evaluate the growth and yield responses of maize in relation to different rates of cow dung applied on maize experimental plots at the Niger Delta University Teaching and Research Farm, Bayelsa State, Nigeria. It was layed-out in a Randomized Complete Block Design (RCBD) with five replicates. The Rates of cow dung applied in tonnes per hectare were 0, 5, 10, 15, and 20. The parameters assessed to achieve the objectives of the study were vegetative characteristics (plant height and leaf area) and yield parameters such as: cob length and girth, average number of kernels/cob, weight of 1000 kernels and yield in tonnes/ha of maize. Treatment means were compared using the least significant difference (LSD) at 5% level of probability ($P < 0.05$). That is 20t/ha of cow dung application significantly had the highest mean value in all the parameters evaluated.

CONCLUSION

This project has created a positive awareness on the importance of Cow dung in bio-fertilizer form on the growth and yield quality of maize production in the Niger Delta Area (Bayelsa State) of Nigeria. Because Cow dung is a sustainable organic manure that contains plant nutrients to improve the quality and quantity of maize production more than the inorganic fertilizers, it has no chemical residual effect on the soil microbes. This result has solved the negative residual effect on our ecosystem. Presently, the Global World is embarking on organic manure to improve soil fertility for maximum crop production. The results of the study showed that plants with treatment of 20 tonnes per hectare of cow dung manure was highly superior and significantly differed from plants with application rates of 15 tonnes/ha, 10 tonnes/ha, 5 tonnes/ha of cow dung and the control plots in vegetative components at ($P <0.05$).

Application rates of 20 tonnes/ha differed significantly from 15, 10, 5 tonnes/ha and the control on the yield parameters assessed excluding yield in tonnes/ha were 20 tonnes differed significantly from the control, while the other rates: 15, 10 and 5 tonnes/ha were not significantly different from the control. Cow dung proved to have been a very rich source of nutrients for maize production, as it greatly enhanced the growth and yield of maize in all ramifications.

Recommendation

Based on the findings of this study, it is recommended that farmers in the study area should adopt the application of 20 tonnes/ha of cow dung bio-fertilizer for optimum growth and yield of maize production to the people of Niger Delta Area of Nigeria and the Global World in general, to safe the problem of food security.

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Appendix I

Plant Height (cm) Data Arranged For RCB Analysis

BLOCKS

Treatments	I	II	III	IV	V	Treatment Totals	Means
0 t/ha	130.60	133.48	136.40	129.70	139.60	669.78	133.96[e]
5 t/ha	138.50	146.20	144.40	148.50	147.20	724.80	144.96[d]
10 t/ha	162.21	144.60	158.10	155.50	152.30	772.71	154.54[c]
15 t/ha	160.40	168.90	165.40	177.50	172.60	844.80	168.96[b]
20 t/ha	180.40	185.20	205.40	181.80	190.60	943.40	188.68[a]
Block Totals	722.11	778.38	809.70	793.00	802.3	3955.49	

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ANOVA Table: For Plant Height (cm) Data

Sources of Variation	D.F	SS	M.S	F. cal	F.tab
Total	24	9994.47			
Block	4	199.49	49.87	1.16	3.01
Treatment	4	9016.28	2276.57	52.89	3.01
Error	16	688.70	43.04		

LSD (P < 0.05) = 8.80

Leaf Area Data (cm) Arranged For RCB Analysis

BLOCKS

Treatmens	**I**	**II**	**III**	**IV**	**V**	**Treatment Totals**	**Means**
0 t/ha	225.50	240.20	228.60	236.21	232.50	1163.01	232.6
5 t/ha	245.20	248.35	250.17	242.44	246.28	1232.44	246.4
10 t/ha	264.45	256.58	268.31	262.22	258.84	1310.40	262.1
15 t/ha	250.40	286.40	255.50	271.10	250.00	1313.40	262.7
20 t/ha	312.42	295.41	288.60	301.30	298.80	1496.53	299.3
Block Totals	1297.97	1326.94	1291.18	1313.27	1286.42	6515.78	

ANOVA Table: For Leaf Area (cm) Data

Sources of Variation	D.F	SS	M.S	F. cal	F.tab
Total	24	13998.71			
Block	4	223.68	55.92	0.67	3.01
Treatment	4	12438	3109.63	37.23	3.01
Error	16	1336.52	83.53		

LSD (P < 0.05) = 12.38

Presented in appendix I above: are data generated from plant height and leaf area of maize arranged for Randomized Complete Block Design (RCBD) and analysis of variance (ANOVA) table showing the: degree of freedom (DF), sum of squares (SS), mean square (MS) Ftab and Fcal as well as the respective least significant values (LSD) at 5% level of significance.

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Appendix II
Cob Length (cm) Data Arranged For RCB Analysis

BLOCKS

Treatments	**I**	**II**	**III**	**IV**	**V**	**Treatment Totals**	**Means**
0 t/ha	11.20	11.45	10.64	11.00	11.82	56.11	11.22[bc]
5 t/ha	12.62	13.60	12.40	12.10	13.41	64.13	12.83[b]
10 t/ha	12.82	14.22	13.49	14.24	14.00	68.77	13.75[b]
15 t/ha	14.64	12.48	14.14	16.31	10.64	68.21	13.64[b]
20 t/ha	16.42	14.23	15.44	14.91	16.54	77.54	15.51[a]
Block Totals	67.70	65.98	66.11	68.56	66.41	334.76	

ANOVA Table: For Cob Length (cm) Data

Sources of Variation	D.F	SS	M.S	F. cal	F.tab
Total	24	75.06			
Block	4	1.02	0.25	0.16	3.01
Treatment	4	48.50	12.13	7.60	3.01
Error	16	25.54	1.60		

LSD (P < 0.05) = 1.70

Appendix IV
Cob Girth (cm) Data Arranged For RCB Analysis

BLOCKS

Treatments	**I**	**II**	**III**	**IV**	**V**	**Treatment Totals**	**Means**
0 t/ha	8.42	5.81	8.30	8.11	8.21	38.85	7.77[d]
5 t/ha	10.41	7.61	9.24	10.44	9.85	47.55	9.15[c]
10 t/ha	11.21	10.68	9.11	11.25	11.81	54.06	10.81[b]
15 t/ha	12.20	11.69	11.47	12.14	12.20	59.70	11.94[b]
20 t/ha	14.42	13.66	10.81	12.84	16.51	68.24	13.65[a]
Block Totals	56.66	49.45	48.93	54.78	58.58	268.40	

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ANOVA Table: For Cob Girth (cm) Data

Sources of Variation	D.F	SS	M.S	F. cal	F.tab
Total	24	133.72			
Block	4	14.91	3.73	3.38	3.01
Treatment	4	101.18	25.29	22.96	3.01
Error	16	17.63	1.10		

LSD (P < 0.05) = 1.41

Appendix V
Average No. of Kernels/Plant Data Arranged For RCB Analysis

BLOCKS

Treatments	**I**	**II**	**III**	**IV**	**V**	**Treatment Totals**	**Means**
0 t/ha	91.00	108.00	136.00	92.00	126.00	553.00	110.60[c]
5 t/ha	100.00	152.00	108.00	184.00	110.00	654.00	130.80[bc]
10 t/ha	145.00	164.00	148.00	154.00	182.00	793.00	158.60[b]
15 t/ha	210.00	189.00	161.00	122.00	202.00	844.00	176.80[b]
20 t/ha	221.00	215.00	231.00	206.00	244.00	1117.00	223.4[a]
Block Totals	767.00	828.00	784.00	758.00	864.00	4001.00	

ANOVA Table: Average No. of Kernels/Plant Data

Sources of Variation	D.F	SS	M.S	F. cal	F.tab
Total	24	51678.96			
Block	4	1597.76	399.44	0.53	3.01
Treatment	4	37983.76	9495.94	12.56	3.01
Error	16	12097.44	756.09		

LSD (P < 0.05) 36.87

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Appendix VI
Weight of 1000 Kernels (grams) Data Arranged For RCB Analysis

BLOCKS

Treatments	**I**	**II**	**III**	**IV**	**V**	**Treatment Totals**	**Means**
0 t/ha	142.02	132.80	124.04	151.00	127.01	676.87	135.37[bc]
5 t/ha	132.52	144.14	164.20	158.77	166.60	766.23	153.25[b]
10 t/ha	155.05	160.00	181.21	171.41	140.02	807.69	161.54[b]
15 t/ha	187.24	200.02	180.00	163.20	188.64	919.10	183.82[a]
20 t/ha	204.00	190.01	165.20	188.33	179.20	926.74	185.35[a]
Block Totals	820.83	826.97	814.65	832.71	801.47	4096.63	

ANOVA Table: Weight of 1000 Kernels Data

Sources of Variation	D.F	SS	M.S	F. cal	F.tab
Total	24	12834.22			
Block	4	116.11	29.03	0.12	3.01
Treatment	4	8948.18	2237.05	9.49	3.01
Error	16	3769.94	235.62		

LSD ($P < 0.05$) = 20.58

Appendix VII
Yield (tonnes/ha) Data Arranged For RCB Analysis

BLOCKS

Treatments	**I**	**II**	**III**	**IV**	**V**	**Treatment Totals**	**Means**
0 t/ha	0.80	4.80	5.91	3.20	5.55	20.26	4.05[aa]
5 t/ha	5.42	5.50	4.54	3.10	5.80	24.36	4.87[a]
10 t/ha	5.51	3.70	6.95	5.88	6.05	28.09	5.62[a]
15 t/ha	6.10	5.11	6.20	6.01	4.60	28.02	5.60[a]
20 t/ha	6.04	5.84	7.40	6.80	6.10	32.18	6.45[a]
Block Totals	23.87	24.95	31.00	24.99	28.10	132.91	

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ANOVA Table: Yield (tonnes/ha) Data

Sources of Variation	D.F	SS	M.S	F. cal	F.tab
Total	24	47.90			
Block	4	6.88	1.72	1.10	3.01
Treatment	4	16.12	4.03	2.59	3.01
Error	16	24.91	1.56		

LSD = 1.68
P < 0.05

Presented in appendix II above: are data generated from yield parameters of maize (cob length and girth, average number of kernels/cob, weight of 1000 kernels, and yield in tonnes/ha) arranged for Randomized Complete Block Design (RCBD) and analysis of variance (ANOVA) table showing the: degree of freedom (DF), sum of squares (SS), mean square (MS) Ftab and Fcal as well as the respective least significant values (LSD) at 5% level of significance.

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