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Investigating Organic Manure and Inorganic Fertilizer for Sustainable Maize (*Zea mays*) Production in Southwestern Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors KOO and AOA designed the study, managed the literature searches and wrote the first draft of the manuscript. Author GEB managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This research investigated the utilization of livestock manure as nutrient source in maize farming.

Place and Duration: The field experiment was carried out at the research field of the Federal Ministry of Agriculture and Rural Development, Lagos State Field Office, Nigeria during the late planting season (July/August) of 2019.

Methodology: An experimental field research was conducted to compare the variation in the vegetative parameters and yields of maize grown with different livestock wastes. The experiment consisted of six treatments, cattle, pig, poultry, sheep manures, NPK and control experiment set-up in a Randomized Complete Block Design with four replicates. The following data were recorded during the experiment: plant height, number of leaves, number of days to first tasselling and silking, number of cob, cob length, effective cob length, cob diameter, cob weight, ear weight, 100 grain weight, grain yield and shelling percentage. Data recorded were exposed to Analysis of Variance (ANOVA) and the means were separated with Duncan Multiple Range Test.

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Results: The plant height and number of leaves recorded at 9 Weeks After Planting were 215.53, 217.57, 219.69, 188.85, 219.19, 182.76 and 13.60, 13.40, 13.8, 12.4, 13.8, 12.2 cm for cattle, pig, poultry, sheep, NPK and control respectively while the yield were 3193.00, 3055.20, 3513.00, 2855.00, 3791.00 and 1523.80 kg/ha for cattle, pig, poultry, sheep, NPK and control respectively.
Conclusion: Considering the yields recorded, it has shown that cattle, pig, poultry and sheep manures are suitable for sustainable maize growth and is a means of livestock waste management.

Keywords: Maize; livestock waste; NPK; height; number of leaves; yield components; yield.

1. INTRODUCTION

Livestock production has contributed immensely to the economy of both developed and developing countries. This branch of agriculture has also provided nutritional security to countries and sustains economic stability. Wastes released through this important field of agriculture cannot be neglected because of its negative impacts on lives and environment [1]. Globally, livestock production keeps on increasing and this makes livestock wastes managements a serious concern in order to have safer environment. Poultry, cattle and pig accounted for more than 2267, 940 and 650 million heads respectively [2]. The changes in livestock production in Nigeria between 1980 and 2015 are as shown in Table 1.

This shows that large quantity of livestock wastes are released to the environment. In a typical manner, animal wastes are not limited to faeces and urine alone but includes other secretions, wasted feed, hair, feather, bedding materials, drinking or flushed water and soil. Therefore, wastes from livestock constitutes serious pollution problem to human and environment especially in areas where the pens are built closed to residential areas. The percentage of NH_3, CH_4 and H_2S released differs according to the level of digestion process and organic materials, the food composition, the health status of the animal and microorganisms. Improper treatment of these animal wastes can lead to the emission of greenhouse gases, negative impact on the soil properties and water pollution. Several deaths were recorded in Walkerton, Canada, in 2000 as a result of drinking water contaminated with livestock waste [4]. The relationship between livestock production and greenhouse gas emission (GHG) has been acknowledged globally, according to Steeg and Tibbo, [5], about 59 – 63% of the non-carbon dioxide greenhouse gas released globally is from agricultural activities, and about 35% of this gas is from livestock farming [6]. The challenges of climate change and global warming can be reduced when rules and regulations guiding the disposal of livestock wastes are abide with [1]. Livestock wastes can be in three forms: solid, slurry and effluent. Solid wastes can be dried or composting, dried wastes are utilized as manure sources for plants and as combustion fuel to release energy. Slurry can be used for liquid composting [7] or for methane production [8], effluent can be used by activated sludge process to produce pure water or uncomplicated aeration technology to produce biofertilizer.

Manures from livestock production have been utilized efficiently as organic fertilizer for years, it has significant amount of accessible nitrogen, carbon and water, hence supplying requisite feedstock for the microbial generation of N_2O via nitrification and denitrification [9]. Livestock waste contains all important plant nutrients and has been recorded as the excellent fertilizer [10]. Among the organic fertilizer, poultry waste has been acknowledged as possibly the most suitable fertilizer as a result of its high nitrogen and phosphorous content [11;12]. It is evident that the appropriate utilization of wastes from livestock production in crop production has been successful and it is a crucial step in proper management of waste generated by livestock.

Table 1. Livestock production trend in Nigeria

Livestock	Years				
	1980 *	**1990 ***	**2001 ***	**2010 ***	**2015***
Cattle	12,108	13,947	15,133	16,578	20,848
Sheep	8,050	12,460	28,693	35,520	41,632
Pigs	1,000	3,410	5,250	7,472	7,368
Poultry (Chicken)	79,760	126,090	124,620	192,313	142,895

**values express in 1,000; Source: [3]*

Fertile soil is important in crop production in order to produced quality crop yield with longer storage life span. Soil fertility improvement is important for sustainable agriculture; therefore, the utilization of inorganic fertilizer or organic manure for soil improvement is an important aspect of crop production. The negative effects of chemical/inorganic fertilizers utilization in agricultural on human health, animal health and environmental challenges have sparked up the interest in organic farming recently. Organic farming embraces human and environmentally benign production systems; it forbids the utilization of man-made chemicals, growth hormones and mineral fertilizers but the utilization of organic and green fertilizers, crop rotation, soil preservation, improved plant resistance and biological control. Zhou et al., [13] noted that the utilization of chemical fertilizers on agricultural soils influenced and expanded spatial unevenness in the allotment of moisture and substratum for microbial development.

The use of wastes from livestock production is an important constituent of sustainable farming and a sources of nutrients and precursor for organic matter for sustainable soil fertility and crop yield; and it has been reported to be efficient and economical [14]. Adelekan et al., [15] reported that digested slurry from poultry waste improved the vegetative parameters of maize. Inorganic fertilizer, poultry manure and cocoa pod husk were used to grow plantain and it was reported that poultry produced the best vegetative growth and yield parameters [16].

Maize is a crucial food crop for several households in Nigeria and people living in the West African countries, out of the two major sources of food that was estimated to be about 40% of the total land cultivated, maize is one, and about 43% of maize produced in West Africa is from Nigeria [17;18;19]. Low yield due to poor soil fertility, due to low use of synthetic fertilizer because of extreme cost and their negative consequences on the environment are some of the challenges faced by maize farmers in Nigeria. Hence, it is important to identify some other nutrient sources that are readily available to enhance the production by supplying nutrients required for soil improvement at relatively low cost and little damage to the environment. Although some researchers have investigated the relationships between growth and yield parameters of maize grown with several nutrients sources especially poultry waste, further research is required to compare other readily available livestock wastes in Southwestern Nigeria.

2. MATERIALS AND METHODS

2.1 Experimental Plot/Site

The field work was carried out at the Research Field of the Nigeria Federal Ministry of Agriculture and Rural Development, Lagos state. The area is in the Southwestern part of the country and situated along the tropical rain-forest zone of Nigeria, and the upper part is derived or guinea savanna vegetation. The State lies on coordinate 6° 35′ N and 3° 45′ E, altitude 39 m beyond the sea level and bimodal rainfall. The State has a tropical climate; the summers receive more rain than the winters with average minimum temperature of 27 °C and average annual rainfall of 1,693 mm [20]. The least minimum rainfall was recorded in December while the highest precipitation was recorded in June. The experiment was carried out in the year 2019 during the late planting season (July/August) which represent the common planting period for late maize in this agro-ecology zone.

2.2 Experimental Design, Treatment and Plot Size

The experiment was set-up in a randomized complete block design (RCBD) with four duplicates. The blocks were arranged from east to west and the surface area of each plot was 2.7 m^2 (1.8 m x 1.5 m), detached by 1m alley. The plots were labeled T_A – T_F as shown in Table 2.

Table 2. Grouping for different nutrient sources

Treatments	Nutrients sources
T_A	Cattle Waste
T_B	Pig Waste
T_C	Poultry Waste
T_D	Sheep and Goat Waste
T_E	Inorganic Fertilizer
T_F	Control (No added nutrient source)

2.3 Experimental Set-up

The site was cleared and ridged manually before marking out the plots. Maize seed was procured from Lagos State Agricultural Inputs Supply Services Centre (LAISSC) in Oko-Oba, Agege and planted at a spacing of 90 cm x 30 cm. Manual weeding was carried out on all the plots at 4 and 8 weeks after sowing. Organic manure and fertilizer application were as shown in Table 2 and for plots treated with organic waste, the nutrients were applied a week prior to seedling at the rate of 1 ton/ha, while for the plots selected for NPK (60:40:40) fertilizer, it was applied two weeks after planting at the rate of 300 kg/ha.

2.4 Data Collection

Growth parameters were assessed randomly and ten (10) maize plants were identified and tagged on each plot from which required data was collected. The plant heights were determined from the tagged plants from the ground plain to the tip of the plant with the use of meter rule and the total number of leaves on each of the plant tagged per plot counted and recorded after 3, 6 and 9 weeks. The duration to first tasseling was the number of days from planting to first tassel and number of days to 50% tasseling was the number of days from sowing to 50% tasseling. Number of days to first silk is the number of days from planting to first silking and number of days to 50% silking is the number of days from planting to 50% silking. Cobs quantity from each plant was recorded and total cob length was measured after removing the husk from the culm from the bone of the cob. Effective cob length was measured as the point of attachment of grain on the culm from the bone of the cob and cob weight was the average weight of five randomly selected cobs per plot and the cob diameter was the circumference of the two extreme points at the widest part of the cob. Ear weight was noted and 100 grain weight was the weight of 100 kernels while grain yield (kg/ha) is the weight of the grain expressed in kilogram per hectare. Shelling percentage was the ratio of weight of seed over weight of cob expressed in percentage.

2.5 Data Analysis

The data accrued was exposed to Analysis of Variance (ANOVA) using SPSS (21.0 version) and means separated with Duncan Multiple Range Test (DMRT), while the significance test was done at 5% probability level.

3. RESULTS AND DISCUSSION

3.1 Effects of Different Treatments on the Maize Height

The application of various nutrient sources and their interaction (Table 3) significantly enhanced maize height at 3 WAP. There was no significant difference amongst T_A, T_B, T_C and T_D but they were significantly above that of T_E and T_F. T_C produced the highest plant tallness and T_F had the shortest plant height. At 6 WAP, T_E produced the tallest plant while T_F produced the shortest plant, but there was no significant difference between T_B, T_C and T_E while that of T_A is higher than T_D. The results also showed that T_C had the highest plant height at 9 WAP but there was no significant difference with T_E while T_F had the least plant height.

Table 3. Effects of different treatments on the plant height

Treatments	3 WAP	6 WAP	9 WAP
T_A	72.68a	168.44b	215.53b
T_B	72.52a	177.38a	217.57ab
T_C	73.27a	179.30a	219.69a
T_D	72.44a	148.07c	188.85c
T_E	69.57b	179.56a	219.19a
T_F	65.44c	122.41d	182.76d
SD	3.00	21.44	15.67

Means followed by the same letter in a column are not significantly different (p<0.05)
SD = Standard Deviation
WAP = Weeks After Planting

The superior performance of maize with regards to plant height in most stages of growth recorded in organic manure treatment as compared to the inorganic nutrient source and control can be attributed to the availability of macro and micro nutrients, growth promoting enzymes and hormones in the organic nutrient sources as earlier reported by [21]. Nutrients available in manures are reported to be liberated moderately and available in the soil for longer period, ensure longer residual impacts and enhance the root growth [22], which can be held accountable for the significant plant height achieved with manure treatments. The result recorded for all the treatments except T_F are higher than what [23] reported for 'ORBA1'variety and higher than what was reported for 'ORBA2' variety except T_D and T_F when NPK and urea fertilizers were used for late maize in derived savannah agro-ecology. All the result except T_D and T_F are in the same range with what [24] reported when 100 kg/ha of NPK fertilizer was used during the 2011 cropping season.

3.2 Effects of Different Treatments on the Number of Maize Leaves

The number of leaves recorded during the experiment is as shown in Table 4. The results show that at 3 WAP, treatments with organic manure produced the highest number of leaves. The higher number of leaves at this stage can be traced to the early supply of minerals from the organic nutrient sources to the plant. T_E was significantly different from T_A, T_B, T_C and T_D far from them despite being applied two weeks after planting because they are readily available nutrient sources compared with organic manures. Therefore, all the nutrient sources released nitrogen on time for the plant usage because nitrogen is responsible for vegetative growth [25]. The results at 6 WAP show that there was no visible difference between T_A, T_B, T_C and T_E while T_D and T_F showed no significant difference.

Table 4: Effects of different treatments on the number of maize leaves

Treatments	3 WAP	6 WAP	9 WAP
T_A	10.2a	12.6a	13.6ab
T_B	9.4ab	12.4a	13.4abc
T_C	9.8a	12.8a	13.8a
T_D	8.4ab	8.4b	12.4bc
T_E	8.0c	12.4a	13.8a
T_F	7.8c	8.2b	12.2c
SD	1.17	2.24	1.06

Means followed by the same letter in a column are not significantly different (p<0.05)

Number of leaves at 9 WAP showed no significant difference between T_C and T_E and this may be due to high nitrogen percentage in the poultry manure and NPK fertilizer. When compared with the results of the earlier researchers, the values obtained here is not far from what [26] reported when NPK fertilizer was used for different spacing of maize. The number of leaves recorded in this experiment is higher than what [27] obtained when different level of NPK fertilizers was used for different sweet corn hybrids in Kharif season. The results reported here supported what was reported as growth parameters of sorghum in a previous study [28]. They reported that poultry manure significantly enhanced the growth of sorghum due to its ability to improve soil physicochemical characteristics. The enhancement of the soil fertility and improvement of soil physical characteristics that leads to better growth can be traced to these organic manures as reported by the earlier researches; that amelioration of soil using livestock manures improved the soil organic matters, nitrogen, potassium, phosphorous, calcium and magnesium [29;30;31;32;33;34]. The higher number of leaves resulted to a better leaf area index which is an indication of good light interception that will lead to enhanced yields and translocation of synthesis to the storage parts of the plant.

3.3 Effect of Nutrient Sources on Number of Days to First Tasseling and Silking, 50% Tasseling and Silking

The results in Table 5 show that the use of organic manures and NPK had significant impact on the days to first tasseling. $\mathbf{T_E}$ gave significantly lower number of days to tasseling when compared with others while it was keenly followed by $\mathbf{T_C}$. There was no significant difference in the number of days to first tasseling between $\mathbf{T_A}$ and $\mathbf{T_B}$, while $\mathbf{T_D}$ and $\mathbf{T_E}$ also differ significantly. Livestock manure and NPK application and their interaction showed significant effects on days to 50% tasseling (Table 5). $\mathbf{T_E}$ had the shortest duration to 50% tasseling and significantly different from other treatments, this was followed by $\mathbf{T_C}$ while $\mathbf{T_A}$ and $\mathbf{T_B}$ showed no significant difference. $\mathbf{T_F}$ was observed to have the longest number of days to 50% tasseling and it was significantly different from $\mathbf{T_D}$ that was close to it. Onwudiwe and Ogbonna, [24] earlier reported 44.67 and 48.00 days for 1.0 t/ha municipal waste and 100 kg/ha for NPK as their days to first tasseling and recorded 54.33 and 55.67 days for 1.0 t/ha municipal waste and 100 kg/ha of NPK respectively while [23] reported 64.23 days for ORBA 1&2 when NPK and urea was used. Comparing the results from these researchers with this study especially at 50% tasseling, it shows that all the treatments performed very well.

On the number of days to first silking, all the treatments showed significant difference. The minimum number of days to first silking was recorded from T_C and T_E, and they were not significantly different while they were followed by $\mathbf{T_A}$ and $\mathbf{T_B}$ that were not also different significantly. The higher number of days to first silking was recorded in $\mathbf{T_F}$ while that of $\mathbf{T_D}$ is also higher and significantly differs from the rest. All the treatments and their interaction showed some significant difference at 50% silking. T_C and T_E produced the shortest number of days to 50% silking, but no significant difference was noticed between T_A, $\mathbf{T_B}$, $\mathbf{T_C}$ and $\mathbf{T_E}$ for the duration of 50% silking. T_D had a prolonged duration to 50% silking but also differs significantly when compared with T_F. These results are similar with what [23] reported for

Table 5. Effects of nutrient sources on number of days to first tassel and silk, 50% tasseling and silking

Treatments	1st tassel	50% tasseling	1st silk	50% silking
T_A	54bd	56bc	59ab	62a
T_B	54bd	57bc	59ab	62a
T_C	52ab	55ab	58a	61a
T_D	55cd	58c	60b	64b
T_E	52a	54a	58a	61a
T_F	56d	60d	64c	67c
SD	1.63	2.16	2.39	2.58

Means followed by the same letter in a column are not significantly different (p<0.05)

50% silking for ORBA 1 and 2 respectively when NPK and Urea was used, but it is higher than what [24] reported for 2011 late planting season when NPK at ratio 100 kg/ha and municipal solid waste at the ratio 1.0 t/ha were applied.

The duration to tasseling and silking recorded in the experiment were significantly improved by the manure application as lower days were recorded due to enhanced nutrient availability. Higher number of days in the control plots was as a result of little/no nutrient in the soil and the improved outcome was recorded in the fertilized plots was as a result of accessibility to nutrients in the soil as a result of manure which was expected to improve the supply of N, P, K, Ca and Mg, thereby improve the vegetative development. These results conformed to the assertion that difference in nutrient sources among treatments will lead to visible difference on vegetative growth of the plant [35].

3.4 Effects of Nutrients Sources on Components and Yield

Results reported in Table 6 show that the application of different nutrient sources significantly enhanced different components and yield. Treatment C produced the highest number of cobs but not visibly different from T_E while T_A, T_B, T_D and T_F followed in that order. The number of cobs recorded in each plant is dictated by the growth behavior of the plant which is also influenced by the agronomical practices, climatic and edaphic factors. The quantity of cob produced by each plant was reported to be the major yield component that determines the yield capacity of the crop. The value recorded for T_C can be traced to the excellent percentage of nitrogen, phosphorous, potassium and other important nutrients that enhanced the soil [36;37]. There was no significant difference among T_A, T_B, T_C and T_E for total cob length and effective cob length except for T_D and T_F. T_C had the highest value of cob diameter; besides, no significant difference was noticed with other treatments except T_F. According to Table 6, values recorded for cob weight were significantly different; T_C had the highest yield and followed by T_E, T_A and T_B shows no significant difference, while no significant difference was recorded between T_C and T_E. The values recorded for these yield components are in agreement with what was reported by the earlier researchers [7;23;24;26].

The values recorded for manures shows that they released both major and trace elements in the required quantities and improved the biological and physical characteristics of the soil [22] while the chemical fertilizer released high quantity of NPK in the required quantities, which leads to better yield components recorded in the treated plots compared to control plot. Uyovbisere and Elemo, [25] earlier reported that the number of fruits produced by each plant, fruit diameter, fruit length and fruit weight were increased substantially when manure with higher nutrients value was applied to the crop, and this may be the reason for better yield components recorded in this experiment. T_C produced the best results because it has readily available phosphorous to release to crops when compared with others [38].

3.5 Effect of Nutrient Sources on Grain Yield

The application of different livestock waste to the maize crop significantly increased the ear weight, weight of 100 grains, grain yield and shelling percentage (Table 7). Significantly higher yield was recorded from T_E, followed by T_C while T_A, T_B, T_D and T_F followed in that order. All the treatments were significantly different except T_A and T_B. T_C produced the heaviest 100 grains weight but being at par with T_A and T_E statistically, the lower 100 grains weight

Table 6. Effect of nutrient sources on number of cob, cob length, effective cob length, cob diameter and cob weight

Treatments	No of cob	Total cob length (cm)	Effective cob length (cm)	Cob diameter (cm)	Cob Weight (g)
T_A	1.07b	19.44a	17.84a	11.33a	198.40b
T_B	1.02c	19.46a	17.71a	11.36a	198.95b
T_C	1.13a	19.72a	17.60a	11.64a	210.67a
T_D	1.01d	17.54b	15.69b	11.09a	164.11c
T_E	1.12a	20.37a	18.77a	10.96a	209.27a
T_F	1.0bc	13.86c	11.09c	8.12b	155.67c
SD	0.43	2.46	2.78	1.42	23.07

Means followed by the same letter in a column are not significantly different (p<0.05)

Table 7. Effect of nutrient sources on grain yield

Treatment	Ear weight (g)	100 grains weight (g)	Grain yield (kg/ha)	Shelling Percentage (%)
T_A	225.31c	36.69a	3193.00c	77.45b
T_B	221.10c	34.48b	3055.20cd	82.42a
T_C	240.97b	38.42a	3513.00b	81.41ab
T_D	192.40d	28.96c	2855.00d	81.36ab
T_E	251.92a	38.35a	3791.00a	80.23ab
T_F	180.50e	25.18d	1523.80e	69.56c
SD	25.83	5.20	749.44	5.45

Means followed by the same letter in a column are not significantly different (p<0.05)

was recorded at T_D which was higher than only T_F. T_E produced the highest grain yield followed by T_C, while T_A, T_B, T_D and T_F followed in that order (Table 7) and they were all differ significantly. In terms of shelling percentage, T_B gave the highest percentage while T_C, T_D and T_E were at par whereas T_A had lower shelling percentage other than T_F that had the lowest shelling percentage. The results for 100 grains in this experiment negate what [39] reported where sheep manure produced better result than cattle manure and this may be as a result of difference in the animal feed as reported by [40].

The better results recorded for the yield components (ear weight and 100 grain weight), grain yield with T_A, T_B, and T_C over T_D as shown in Table 7 may be linked to higher availableness of phosphorous and some nutrients needed by the plant [39]. These set of results recorded for grain yield are higher than 1,528 kg/ha maize yield recorded by [41] in Nigeria, and are within the range of yield projected (2,000 – 3,000 kg/ha) by [42] for open pollinated maize in southern Nigeria. The set of the results recorded for 100 grains weight and shelling percentage agree with what [39] recorded for sheep, poultry and cattle but higher grain yield was recorded when compared. Also, the results for 100 grains weight, and yield recorded is in the same range with what [7] recorded when urea and Farm Yard Manure was applied. The results of the findings of this research are in agreement with the findings of earlier researchers on the uses of organic wastes from poultry, sheep, cattle and pig as a replacement for inorganic fertilizer [33;39;43] and it is a sustainable means of fertilizing maize due to its availability and cost [44]. T_C seems to produce the best results among other livestock manure because it has been reported to supply more phosphorous to plants when compared with other manure source as a result of phosphate activity [38].

4. CONCLUSION

Soil treatment with organic manures (cattle, pig, poultry and sheep manure) gave a good result when compared with inorganic fertilizer and untreated plot. For a treatment to be declared efficient, the benefits achieved must outweigh the cost implication. The exorbitant cost of chemical fertilizers that is a major challenge to the farmers can be addressed by applying these wastes that are readily available. The use of these livestock manures for maize production needs to be encouraged among the maize farmers in Southwestern Nigeria as means to improve the livelihood through improved yield of the maize and to have a healthy environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Singh A, Rashid M. Impact of animal waste on environment, its management strategies and treatment protocols to reduce environmental contamination. Vet. Sci. Res. J. 2017;8(1&2):1-12.
2. EPA, Animal waste – What is the problem? 2015.
Available:http://www.epa.gov/region9/animalwaste/problem.html
3. FAOSTAT. Live Animals. Food and Agriculture Organization of the United Nations, Rome, Italy; 2020.
Available:www.fao.org
(Accessed on 29/08/2020).
4. Catelo A, Moises AD, Elpidio A. Living with livestock*:* Dealing with pig waste in the Philippines. Summary of EEPSEA Research Report; 2001.
5. Steeg JV, Tibbo M. Livestock and climate change in the near east region. Measures to adapt to and mitigate climate change. Food and Agriculture Organization of the United Nations. Regional Office for the Near East, Cairo; 2012.
6. McMichael AJ, Powles JW, Butler CD, Uauy R. Food, livestock production, energy, climate change and health. The Lancet. 2007;370(9594):1253–1263.
7. Shah STH, Zamir MSI, Waseem M, Ali A, Tahir M, Khalid WB. Growth and Yield Response of Maize (*Zea mays L.*) to organic and inorganic sources of Nitrogen. Pak. J. life soc. Sci. 2009;7(2):108-111.
8. Ogunkunle O, Ahmed NA, Olatunji KO. Biogas Yields Variance from Anaerobic Co-Digestion of Cow Dung with Jathropha Cake under Mesophilic Temprature. J. Phys: Conf. Ser: 2019;1378 032060.
9. Materechera SA, Mkhabela TS. The effectiveness of lime, chicken manure and leaf litter ash in ameliorating acidity in a soil previously under black wattle (*Acacia mearnsii*) plantation. Biores. Tech. 2002;85:9-16.
10. Bell DD. Waste Management. In: Chicken meat and egg production, 5th edition (Bell DD, Weaver Jr, WD, Eds). Kluwer Academic publisher. Massachusetts; 2002.
11. Sloan DR, Kidder G, Jacobs RD. Poultry manure as a fertilizer. University of Florida, USA; 2008.
12. Mokwunye U. Meeting the phosphorus Needs of the soils and crops of West Africa: The Role of Indigenous Phosphate rocks. Paper presented on Balanced Nutrition Management systems for the Moist Savanna and Humid Forest Zones of Africa at a symposium organized by IITA at Ku Leuva at Cotonun, Benin Republic; 2000.
13. Zhou C, Liu Z, Huang ZL, Dong M, Yu XL, Ning P. A new strategy for co-composting dairy manure with rice straw: Addition of different inocula at three stages of composting. Waste Management. 2015;40: 38-43.
14. Lu H, Lashari MS, Liu X, Ji H, Li L, Zheng J, Pan G. Changes in soil microbial community structure and enzyme activity with amendment of biochar-manure compost and pyroligneous solution in a saline soil from Central China. European Journal of Soil Biology. 2015;70:67-76.
15. Adelekan BA, Oluwatoyinbo FI, Bamgboye AI. Comparative effects of undigested and anaerobically digested poultry manure on the growth and yield of maize (*Zea mays, L*). African Journal of Environmental Science and Technology. 2010;4(2):100-107.
16. Mintah P, Frimpong-Anin KOJ, Annor B. Exploiting organic waste and inorganic fertilizer for sustainable production of plantain (Musa spp.) in Ghana. Journal of Global Agriculture and Ecology. 2017;7(2): 82-90.
17. McCann JC. Maize and Grace: Africa's encounter with a New World Crop, 1,500-2,000. Harvard University Press, Cambridge, Massachsetts and London, England; 2005.
18. Iken JE, Amusa NA. Maize research and production in Nigeria. Afr. J. Biotechnol. 2004;3(6):302–307.
19. Philip D. Evaluation of social gains from maize research in the Northern guinea savannah of Nigeria. In: Impacts, challenges and prospects of maize research and development in West and Central Africa proceedings of a regional maize workshop, IITA-Cotonou, Benin Republic; 2001.
20. Lagos. About Lagos, Lagos State Government; 2018.

Available:http//:www.lagosstate.gov.ng. (Accessed on 23/11/2019).

21. Egene EA. Effect of organic and inorganic fertilizer on the growth, development and yield of okra (*Abelmoschus esculentus* I. Moench) in Kogi state. B. Agric project submitted to the Department of Crop Production, Kogi State University, Anyigba. 2011;37.
22. Abou El-Maged, MM, Hoda AM, Fawzy ZF. Relationship, growth and yield of Broccoli with increasing N, P, K, ratio in a mixture of NPK fertilizers. Annuals of Agricultural Science. 2005;43(20):791–805.
23. Uba CU, Agbo CU, Chukwudi UP, Efusie AA, Muojiama SO. Field evaluation of yield and yield component traits of breeding lines of maize over two seasons' in Derived Savannah Agro-Ecology. Not Sci Biol. 2018;10(4):567-574.
24. Onwudiwe N, Ogbonna P. Effect of Solid Waste and NPK on Growth and Yield of Maize. LAP LAMBERT Academic Publishing, Germany; 2014.
25. Uyovbisere EO, Elemo KA. Effect of inorganic fertilizer and foliage *Azadriachta* and Parkia species on the productivity of early maize. Nigeria Journal of soil Research. 2000;1:17-22.
26. Ukonze JA, Akor NO, Ndubuaku UM. Comparative analysis of three different spacing and the performance and yield of late maize Etche local government area of Rivers state, Nigeria. African Journal of Agricultural Research. 2016;11(13):1187-1193.
27. Thorat, NH, Dhonde, AS, Shelar, DN, and Mohite, A.B. Response of different sweet corn (*zea mays saccharata sturt*) hybrids to various fertilizer levels in Kharif season. Eco. Env. & Cons. 2016;22(1):313-317.
28. Agbede TM, Ojeniyi SO, Adeyemo AJ. Effect of poultry manure on soil physical and chemical properties, growth and grain yield of Sorghum in South West Nigeria. Am. Eurasian J. Sustain. Agric. 2008;2(1): 72-77.
29. Hamma IL, Ibrahim U, Haruna M. Effect of poultry manure on the growth and yield of cucumber (*Cucumis sativum* L.) in Samaru, Zaria. Nigerian Journal of Agriculture, Food and Environment. 2012; 8(1):94-98.
30. Adeniyan ON, Ojeniyi SO. Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. Nig. J. Soil Sci. 2005;15:34-41.
31. Ndaeyo NU, Ukpong ES, John NM. Performances of okra as affected by organic and inorganic fertilizers on an utisol. Proceedings of the 39th Conference of the Agricultural Society of Nigeria. 2005;206-209.
32. Adenawoola AR, Adejoro SA. Residual effects of poultry manure and NPK Fertilizer residues on soil nutrient and performance of Jute (*Corchorus olitorius* L.). Nig. J. Soil Sci. 2005;15:133-135.
33. Moral R, Moreno-Caselles J, Perez MN, Espinosa P, Pardes C, Sosa F. Influence of fresh and composted slurry fraction of swine slurry on the yield of cucumber (*Cucumis sativus* L.). Communications in Soil Science and Plant Analysis. 2005; 36(416):517-524.
34. Smith MAK, Ayenigbara EA (2001). Comparative growth and nutrient composition of Indian spinach in an enriched humid tropical environment. African Crop Science Conference. Proceedings. 2001;5:1007-1013.
35. Ayoola OT, Adeniyan ON. Influence of poultry manure and NPK fertilizer on yield and yield components of crops under different cropping systems in south west Nigeria. Afr. J. Biotechnol. 2006;5(15): 1386-1392.
36. Oyewole CI, Oyewole AN. Crop production and the livestock industry, the interplay: A case study of poultry manure and crop production. Proceeding of the 16th Annual Conference of ASAN. 2011;124-127.
37. Malaiya S, Tripathi RS, Shrivastava GK. Effect of variety, sowing time and integrated nutrient management on growth, yield attributes and yield of summer maize. Annals Agri. Res. 2004;25:155-158.
38. Garg S, Bahla GS. Phosphorus availability to maize as influenced by organic manures and fertilizer P associated phosphatase activity in soils. Bioresource Technology. 2008;99(13):5773-5777.
39. Amanullah K and Khalid S. Integrated use of phosphorous, animal manures and bio-fertilizer to improve maize production under semiarid condition. Organic Fertilizer – From Basic to Applied Outcomes. Intech Open; 2016.
Available:http://dx.doi.org/10.5772/62388
40. Hai HT, Tuyet NTA. Benefits of the 3R approach for agricultural waste management (AWM) in Vietnam. Under

the Framework of joint Project on Asia Resource Circulation Policy Research Working Paper Series. Institute for Global Environmental Strategies supported by the Ministry of Environment, Japan; 2010.

41. World Bank. World Bank collection of development indicators. Nigeria maize yield; 2011.
Available:www.tradingeconomics.com. (Accessed 09/08/2018).
42. IITA. In: Research to nourish Africa. Maize Overview. International Institute of Tropical Agriculture, Ibadan, Nigeria; 2006.
Available:www.iitaresearch.org
43. Ayoola OT, Makinde EA. Complementary organic and inorganic fertilizer application: influence on growth and yield of cassava/maize/melon intercrop with a relayed cowpea. Aust. J. Basic .& Appld. Sci. 2007;1(3):187-192.
44. Tejada M, Hernandez MT, Garcia C. Soil restoration using composted plant residues: Effects on soil properties. Soil Tillage Res. 2009;102(1):109-117.

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