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Suitability of Rice Husk and Chicken Droppings as Organic Fertilizer for Sustainable Agriculture in Ghana

S. M. Murimi
S. F. Gbedemah

ABSTRACT

This study experiments the suitability of using rice husk and chicken droppings to produce organic fertilizer. This is achieved by composting rice husk and chicken droppings mixture in treatment ratios of 2:0, 2:1, 2:2 and 2:3 by volume, with an objective to establish the optimum combination ratio which can produce the highest total nitrogen content and a low carbon to nitrogen ratio acceptable in farming. The study utilizes a Completely Randomized Design (CRD). The experiment involves four treatments with three replicates. The treatments are done by increasing the volume of mixture of chicken droppings added to rice husk waste. Water, comprising 40% by volume of rice husk and chicken droppings mixture is also added to all treatments. The total organic carbon and total nitrogen content of composting materials are analyzed after every 28 day and on the last day of composting. Finished compost quality in terms of total nitrogen content, are significantly increased by enriching rice husk waste with chicken droppings, while the carbon to nitrogen ratio are significantly reduced in most treatments. Analysis of the results shows that the best treatment combination are mixing rice husk waste with chicken droppings at the ratio of 2:2 and 2:3. The treatment combination ratio of 2:2 has 2.26% of the total nitrogen content, which is higher than the treatment combination ratio of 2:3 which has 2.23% of the total nitrogen content while both treatments have C:N ratio of below 20 which is acceptable in organic fertilizer production for use in agriculture. The conclusion is that composting rice husk and chicken droppings mixture in treatment ratio of 2:2 is the best for use on farms to improve nutrient of soils for plants utilization.

Keywords: *Rice husk, chicken droppings, compost, field experiment, organic fertilizer*

INTRODUCTION

The world's agricultural economy is expanding due to increasing human population and advanced technology and globalization. For four decades, rising food demand has

S. M. Murimi *and* ***S. F. Gbedemah**** *are in the Department of Development & Environmental Studies, Wisconsin International University College, Ghana. *E-mail: fgbedemah@hotmail.com.*

encouraged 30% increase in crop land and intensified agricultural practices (Hazel and Wood, 2008; Edgerton, 2009). Agriculture is the major source for economic and foreign exchange earner and growth for African countries (Edeme, Ifelunini and Nkalu, 2016). Cereals like sorghum, millet, wheat, maize and rice are the major staple food for most of Africa's population (Adebayo and Ibraheem, 2015). It is no secret that, subsistence agriculture is mostly practiced by majority of small holder farmers in Africa where "yield gaps are high and poor soils, amongst other constraints add to the difficulties for sustainable farming and incomes" (Macauley, 2015). Ghana economy relies on agriculture, natural resources, such as gold, timber, diamonds, aluminum, manganese, fossil oil, fish, rubber and hydro power (MOFA, 2013).

The number of certified small-scale organic farmers in Africa is relatively high. For instance, in 2009 Uganda was the country with the largest number of certified producers in the world, with Ethiopia, Tanzania and Burkina Faso also among the top ten (Willer and Kilcher, 2009). However, organic-certified agricultural land and products in Africa remains limited despite intensive research on the continent. Agriculture is the predominant economic sector in Sub-Saharan Africa (SSA), with 70% of rural households depending on it as a source of their livelihoods. Some of the staple food-crops produce in Ghana are maize, rice, sorghum and millet (Tanko, Deng and Dossou, 2017). According to FAO (2010), the average fertilizer (Nitrogen and Phosphorus) consumption is 16.24 kg/ha which is less than 16.54% compared to the world consumption of 98.20 kg/ha. Increasing productivity of the small holder farmers, bridging the yield gaps by providing appropriate inputs in the form of manure along with improved technologies such as stress resistant and high yielding varieties will be a step towards agricultural transformation in Africa.

In Ghana, for the year 2012, paddy rice harvested were 481 metric tons which produced milled rice of 332 metric tons while maize production stood at 1950 metric tons and sorghum 280 metric tons (MOFA, 2013). Notwithstanding, production did not meet domestic consumption because between 2012 and 2013 the country imported 151,258 metric tons of maize, 508,529 metric tons of rice and 320,000metric tons of wheat (MOFA, 2013). This is attributed to poor farming technologies and lack of mechanization, infertile soils, lack of labour, pest and diseases among others. Due to this, fertilizer usage increases year by year (FAO, 2005). Between 2008 and 2012 fertilizer use increased from 43176 metric tons to 176000 metric tons (MOFA, 2013). In terms of cost, a bag of fertilizer in 2012 was GH¢76 for NPK, GH¢72 for urea and GH¢53 for sulphate of ammonia per 50kg bag (MOFA, 2013). In 2016, NPK fertilizer cost was GH¢85 and in 2017 the cost was increased to GH¢115 per 50kg bag (IMANI, 2017). To reduce the fertilizer input cost to poor farmers, and to increase productivity, it is economical to supplement the inorganic fertilizers with organic fertilizers. Organic fertilizers can be produced at the farm level through composting of agricultural waste (Adebayo and Ibraheem, 2015). This study is of the opinion that, various agricultural wastes in Ghana can be utilized for this purpose. Some include maize stalks, rice husk, rice straw, sorghum husk, millet husk, cassava peelings, cocoa shells, cocoa pods among others. Majority of these wastes are left in the field and later burnt to facilitate land preparation. In rice producing areas, like Kpong Irrigation Project (KIP) in Asutsuare catchment area, after rice is harvested, rice straw is left in the field, paddy rice is transported and dried at milling machine premises for which rice bran and rice husk are discarded as waste. Rice bran is sold to pig and poultry farmers and rice husk is left at the milling machine which pile up and later burnt to reduce their volume.

Fig. 1: Waste of Rice Husk Pile in Asutsuare, Ghana
Source: Authors, 2017

Composting is a natural biological process which involves the aerobic decomposition of organic materials under controlled conditions (Rynk, Kamp, Wilson, Richard, Kolega, Lucien, Kay, Murphy, Hoitink and Brinton, 1992). These agricultural waste materials can be composted to produce compost when mixed together in correct proportions that leads to C:N ratio between 25-30 which is the best for microbial decomposition ((Huang, Wong, Wu and Nagar, 2004). The objectives of the study are to establish the optimal rice husk and chicken droppings mixture ratio that can produce highest nitrogen content organic fertilizer and to analyze the carbon to nitrogen (C:N) ratio development of organic fertilizer.

MATERIALS AND METHOD

Completely randomized research design was employed for this study. Randomization is the practice of "assigning treatments to experimental units such that each unit is equally likely to receive each treatment" (Casler, 2015). The research was conducted in Asutsuare, Shai-Osudoku District which is situated in the South Eastern part of the Greater Accra region of Ghana. The study involved composting of rice husk and chicken droppings waste within the District. A completely randomized design (CRD) is the simplest design for comparative experiments, as it uses only two basic principles; randomization and replication. The use of CRD assumes homogeneity of the experimental field (Mead, Gilmour and Mead, 2012). Plate 2 is a completely randomized field layout.

Plate 2: Completely randomized design field layout
Source: Authors, 2017

Randomization is allocation of treatments at random to experimental units and replication is repetition of the same treatment in the experimental layout so as to control the effect of extraneous variables. In CRD, the treatments are allocated to the experimental units or plots in a completely random manner (Williams, Matheson and Harwood, 2002). It is assumed that on average, extraneous factors will affect treatment conditions equally, so any significant differences between conditions can fairly be attributed to the independent variables (Fisher, 1935; Bailey, 2008). The experiment utilized heap composting method which is economical to set up, easy to manage composting activities in small scale operation. Moreover, it is easy to monitor and collect data. The experiment had 4 treatments with 3 replications. Treatments were in ratios of rice husk to chicken droppings by volume:

(a) Treatment 1 (RP0) - 0.2m^3 : 0m^3
(b) Treatment 2 (RP1) - 0.2m^3 : 0.1m^3
(c) Treatment 3 (RP2) - 0.2m^3 : 0.2m^3
(d) Treatment 4 (RP3) - 0.2m^3 : 0.3m^3

The following steps were followed;

i. 12 separate transparent polythene sheets were laid out on the ground.
ii. The volumes of rice husk and chicken droppings were measured according to treatment ratios and randomly assigned to treatment units in a complete manner.
iii. Rice husk and chicken droppings were mixed to achieve a uniform consistency.
iv. Water was then added to moisten the material at 40% of the total treatment volume and all materials were mixed again with shovel to achieve homogeneity.
v. Composting materials were then heaped to form a conical shape of 0.75 meters in height.
vi. The composting materials were then covered with polythene sheet materials so as to maintain constant temperature and moisture for a period of 84 days.
vii. Turning or mixing the composting materials with shovel for uniform distribution of micro organism and oxygen was done after every 14 days.
viii. Monitoring and recording of temperature was done every 14 days.
ix. Every 28 days composting materials is expected to have significant change in their chemical composition and sampling of 300grams for laboratory analysis was done to evaluate total nitrogen content and organic carbon content.
x. Proper decomposition of organic materials was expected to take 84 days and this was counted from the first day of setting up the experiment where composted materials were then referred to as organic fertilizer ready for use.
xi. After 84 days final samples of 300grams were taken for laboratory analysis to determine final total nitrogen content and organic carbon content.

After 84 days, it was expected that the compost shall be ready for use in agriculture as it was expected that total nitrogen content shall be above 2%, C:N ratio be between 10 and 20. The compost shall have attained a pH value of between 5.5 and 8.5 and temperature should be at 40^{0}C or below. All these parameters determine the quality and maturity of compost (Epstein, 1997; Antil, Raj, Abdalla and Inubushi, 2014). This study is based on the recommendation by McClintock (2005) that if nitrogen content is below 2%, it means that the compost is low in one of the major macro-nutrients for plants growth, when pH is below 5.5, it means that compost is acidic and can lower soil pH and when it is above 8.5, it means that compost is alkaline and can raise soil pH. Also, when temperature of above 40^0C means that the compost is not mature and decomposition is still taking place. But when it is below 40^0C, it indicates that decomposition has reduced drastically and compost is mature for use in farming practices (McClintock, 2005). The result is done using contrast analysis to compare treatment RP0 against RP1, RP2 and RP3; RP1 against RP2 and RP3; RP2 against RP3 at alpha level of 5%.

The results of data of composting materials during composting period were analyzed using GenStat 12th edition statistical package. This included analysis of variance (ANOVA) and least significant difference (LSD) with an objective to establish and recommend the rice husk to chicken droppings waste ratio appropriate to produce high quality organic fertilizer for use in agricultural activities in Asutsuare and Ghana as a whole.

RESULTS AND DISCUSSION

Total nitrogen content

The result of experiment about the effect of rice husk to chicken droppings ratio on the total nitrogen content changes in composting materials were analyzed in the laboratory of the University of Ghana Agricultural science department at the 1st day, 28th day,56th day and 84th day as represented in Table 1. Total nitrogen content increased gradually in all compost treatment piles except for treatment 1 (RP0) as shown in (Table 1). The increase in the total nitrogen content during the composting process might be due to the activity of nitrogen fixing bacteria which was expected to exist in the composting treatment piles. These bacteria have the capability to fix N2 from the air to NO3 contained in the treatment piles (Bishop and Godfrey, 1983). Huang, Wong, Wu and Nagar (2004) found the same results where the nitrogen content in the compost slightly increased after 63 days of composting.

At the end of composting, treatment piles RP1, RP2, and RP3, contained higher total nitrogen content of 1.92%, 2.26% and 2.23%, respectively than that of treatment pile 1 (RP0) which contained 0.31 % total nitrogen content (Table 1) meaning the compost is not good to be used on plants. This can be contrasted with the primary nutrients (nitrogen (N) – phosphorus (P) – potassium (K) in NPK fertilizer. A bag of NPK chemical fertilizer contains 10% nitrogen, 10% phosphate and 10% potash showing higher amount of nitrogen compared to that of the compost but we can say that getting a value of 2.26% in our compost will help grow crops on a sustainable basis compared to chemical fertilizers which can and do leach into nearby fields and water systems.

The one-way analysis of variance is to determine whether there is any statistically significant difference between the means of two or more independent groups from the rice husk and chicken droppings composting experiment for the four treatments namely; RP0, RP1, RP2 and RP3 which were replicated three times. After analysis of variance the null hypothesis was rejected as f-calculated from ANOVA was greater than f-tabulated from f-distribution table (100.18>4.066). It is thus concluded that incremental addition of chicken droppings amount into rice husk waste had significant effect in improving the total nitrogen content of organic fertilizer. To determine which mean or means is different from the other, F-protected least significant different test was done and the following results were obtained as shown in table 2.

The result of compost analysis (Table 2) on the total nitrogen content shows that treatment 3 (RP2) provided the highest total nitrogen content (2.257%), followed by treatment 4 (RP3) which provided total nitrogen content of (2.23 %), next treatment 2 (RP1) which provided total nitrogen content (1.923%) and finally treatment 1 (RP0) which provided total nitrogen content of (0.313%). The result of the F-Protected LSD test (Table 2) shows that treatment 1 (RP0) is different from treatment 2 (RP1), treatment 3 (RP2) and treatment 4 (RP3). Next, treatment 2 (RP1) is different from treatment 3 (RP2) and treatment 4 (RP3), but treatment 3 (RP2) is not far different from treatment 4 (RP3).

The contrast analysis was done to compare treatment RP0 against RP1, RP2 and RP3; RP1 against RP2 and RP3; RP2 against RP3 at alpha level of 5%. In contrast analysis, there was nitrogen increment in RP1, RP2 and RP3 against RP0 and the results were significant at á = 0.05 with p-value <0.001. In contrast analysis for the nitrogen increment in RP2 and RP3 against RP1, the results show that RP2 and RP3 nitrogen increments were significantly different from that of RP1 at á = 0.05 with p-value = 0.022. While contrast analysis for the nitrogen increment between RP2 and RP3, the results show that the nitrogen increment in both treatments are significantly not different at á = 0.05 with p-value = 0.843. This indicates that the compost from these two treatments RP2 and RP3, when applied to crops will produce the same results of increasing the yield.

Carbon to Nitrogen (C:N) ratio development of organic fertilizer

The result of the experiment on the effect of rice husk to chicken droppings ratio on the carbon to nitrogen ratio development in composting materials were analyzed in the laboratory at the 1st day, 28th day, 56th day and 84th day as represented in Table 3. The C:N ratio of all treatments piles in this study decreased with the increase in composting time to between 15 and 20 at the end of composting period of 84 days, indicating that the compost reached maturity for treatments RP1, RP2 and RP3 except for treatment 1 RP0 (Table 3). There was no difference in the changes of C:N ratio in the compost treatment pile 1 (RP0). All the other treatments piles RP1, RP2 and RP3 except RP0 showed C:N ratio decreases with composting time; whereas RP0 showed little change which is attributed to low nitrogen level at this treatment. The one-way analysis of variance is to determine whether there is any statistically significant difference between the mean of two or more independent groups from the rice husk and chicken droppings composting experiment for the four treatments namely; RP0, RP1, RP2 and RP3 which were replicated three times. After analysis of variance the null hypothesis was rejected as f-calculated from ANOVA was greater than f-tabulated from f-distribution table (3457.13>4.066), and concluded that incremental addition of chicken dropping into rice husk waste had significant effect in reduction of the C:N ratio of organic fertilizer. To determine which mean is different from the other, F-protected least significant different test was done following results obtained as shown in table 4.

The result of compost analysis (Table 4) of the carbon to nitrogen ratio shows that the treatment 1 (RP0) provided the highest carbon to nitrogen ratio of (106.59%), followed by treatment 2 (RP1) which provided carbon to nitrogen ratio of (14.75%), next treatment 3 (RP2) which provided carbon to nitrogen ratio of (11.61%) and finally treatment 4 (RP3) which provided carbon to nitrogen ratio of (10.75%). The result of the F-Protected LSD test (Table 4) shows that treatment 1 (RP0) is different from treatment 2 (RP1), treatment 3 (RP2) and treatment 4 (RP3). Next, treatment 2 (RP1) is different from treatment 3 (RP2) and treatment 4 (RP3), but treatment 3 (RP2) is not far different from treatment 4 (RP3).

Contrast analysis was done to compare treatment RP0 against RP1, RP2 and RP3; RP1 against RP2 and RP3; RP2 against RP3 at alpha level of 5%. In the contrast analysis, there was C:N ratio reduction in RP1, RP2 and RP3 against RP0 and the results were significant at á = 0.05 with p-value <0.001. In contrast analysis for the C:N ratio reduction in RP2 and RP3 against RP1, the results show that RP2 and RP3 C:N ratio reduction was significantly different from that of RP1 at á = 0.05 with p-value = 0.07. While contrast analysis for the C:N ratio reduction between RP2 and RP3results shows that both treatments are significantly not different at á = 0.05 with p-value = 0.468. This indicates that the compost from these two treatments RP2 and RP3, when applied to crops will produce the same results of increasing yield. According to the findings, the rate of decomposition of rice husk and chicken droppings was correlated to the number of days of decomposition. This is shown in figure 3.

During the decomposition process, carbon is used as an energy source for microorganisms, while nitrogen is assimilated in the microorganism's cell protein and other components (Maeda, Hanajima, Toyoda, Yoshida, Morioka and Osada, 2011). Thus, higher initial nitrogen content promotes decomposition. Gross mineralization of nitrogen continued to increase with time which was always higher in treatments with C:N ratio below 30 and these are in all treatments but more higher in treatment 3; RP2 (2:2) and treatment 4; RP3 (2:3). This shows that incremental addition of chicken droppings to waste rice husk had significant effect in improving the total nitrogen content of organic fertilizer, and also incremental addition of chicken dropping to waste of rice husk had significant effect in reduction of the C:N ratio of organic fertilizer. Further analysis of all treatment's mean showed that treatment 3, RP2 (2:2) and treatment 4, RP3 (2:3) are significantly not different and their total nitrogen content and carbon to nitrogen ratio are statistically the same.

Development is said to be sustainable when it 'meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987). In Ghana, sustainability principles are yet to be fully practiced on a commercial basis on farms especially in rice farming. Sustainable agriculture and food security in Ghana stand a chance of increasing productivity of the land and improving the well-being of the poor who are farming especially on the Accra plains (FAO, 1996). Since sustainability is currently being promoted in every human endeavor, farmers in Ghana have no choice but to practice it and using manure in the form of rice husk and poultry droppings is the way to go.

Sustaining agricultural production in Ghana means farmers should consider practical farm management techniques which can enhance productivity and improve incomes. This study believes that growth in the agricultural sector is the most effective way to reduce poverty and thereby increases food security (Dewbre, Cervantes-Godoy and Sorescu, 2011) and this can be done through the support that is offered to existing smallholders. The results of this study also indicate that nutrient quality of compost fertilizer from waste of rice husk and poultry droppings can be enhanced by composting the mixture of the two ingredients. The results from the experiment indicate that incremental addition of chicken droppings amount into rice husk waste had significant effect in improving the total nitrogen content and reducing the C:N ratio of the organic fertilizer. Findings from this study shows that the best rice husk to chicken droppings waste ratio to produce high quality organic fertilizer for use in agricultural activities in Asutsuare and Ghana as a whole can be said to be 2:2 as it can provide highest nitrogen content of 2.26% with a C:N ratio of 11.57 which is below 20 and within the acceptable range for efficient crop production (McClintock, 2005; Ofori and Anning, 2017). This results therefore shows that the organic fertilizer of treatment 3; RP2 (2:2) and treatment 4; RP3 (2:3) produce the highest amount of the total nitrogen content. The results also show that the organic fertilizer of treatment 3; RP2 (2:2) and treatment 4; RP3 (2:3) produce the lowest amount of carbon to nitrogen ratio and these two parameters of total nitrogen content and carbon to nitrogen ratio making these two treatments appropriate for use in farming purposes. The high nitrogen content in the experiment means that the organic fertilizer have enough nitrogen for plant absorption when applied to the soil and low carbon to nitrogen ratio means that there shall be no further assimilation of more nitrogen by microorganism to decompose organic matter as there is low carbon content available to supply enough energy required by microorganisms during decomposition process (Oladejo and Fasan, 2015; Ofori and Anning, 2017).

The final compost of treatment 3; RP2 (2:2) and treatment 4; RP3 (2:3) are significantly not different and both would produce the same results in terms of total nitrogen content and carbon to nitrogen ratio when used as organic fertilizer in farming purposes and the choice of any one against the other shall only depend on the cost of production. Ministry of Food and Agriculture can utilize the findings in training extension staff so that they can train the farmers on-farm composting methods so as to reduce waste pollution either through indiscriminate disposal and burning but rather convert it into organic fertilizer for healthier food production and as a mean of earning income. This shall reduce importation cost of inorganic fertilizers, reduce the use of synthetic chemicals; reduce dependency on fossil fuels and natural gas in the manufacture of fertilizers. This shall significantly reduce the greenhouse gas emission that causes global warming and climate change. This shall greatly enhance and promote biodiversity. Through farmers' adoption and migrating into organic agriculture, the following sustainable development goals shall be achieved:

i. Zero hunger - More and sustainable food production as most farmers can prepare their organic fertilizer and enough food for their families and surplus for sale.
ii. No poverty - The farmers can save substantial income by savings from money that otherwise would have been used to buy inorganic fertilizers. The savings can be used to expand investment leading to economic growth and sustainability.
iii. Good health and well-being - There shall be more organic food production with little synthetic chemical contaminants that promote good health and well-being of the people.
iv. Clean water and sanitation - The volumes of waste disposal at landfills and field burning shall be greatly reduced, which shall reduce emissions of methane and carbon dioxide that cause global warming and climate change.

Table 1: Changes in total nitrogen content during composting of rice husk with chicken droppings (%)

	Days			
Treatment	**0**	**28**	**56**	**84**
RP0	0.30	0.32	0.32	0.31
RP1	0.89	1.11	1.14	1.92
RP2	1.13	1.39	1.59	2.26
RP3	1.25	1.55	1.62	2.23

Source: Experimentation, 2017

Table 2: The result of F-Protected LSD test on the effect of rice husk to chicken droppings ratio on total nitrogen content of the final compost

Treatment	**Mean**	**Significance**
RP0	0.313	a
RP1	1.923	b
RP2	2.257	cd
RP3	2.23	d

Note: RP0=2:0, RP1=2:1, RP2=2:2 and RP3=2:3; LSD Calculated = 0.3011; P_{value} <0.001
Source: Experimentation, 2017

Table 3: Changes in C:N ratio during composting of rice husk with chicken droppings

	Days			
Treatment	**0**	**28**	**56**	**84**
RP0	115.04	110.14	107.77	106.57
RP1	35.46	28.15	25.07	14.54
RP2	24.38	18.06	16.43	11.57
RP3	21.39	16.03	15.02	10.76

Source: Experimentation, 2017

Table 4: The result of F-Protected LSD test on the effect of rice husk to chicken droppings ratio on carbon to nitrogen ratio of the final compost

Treatment	**Means**	**Significance**
RP3	10.75	a
RP2	11.61	ab
RP1	14.75	c
RP0	106.59	d

Note: *RP0=2:0, RP1=2:1, RP2=2:2 and RP3=2:3; LSD Calculated = 2.61437;* P_{value} <0.001
Source: Experimentation, 2017

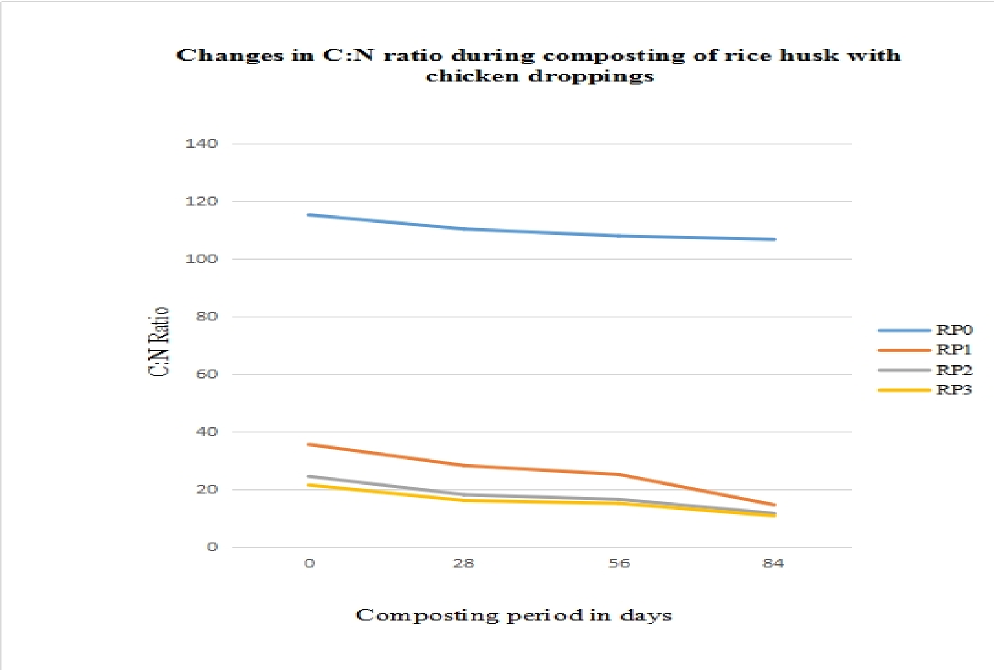

Figure 3: Graph showing changes in C:N ratio during composting of rice husk and chicken droppings for a period of 84 days.

CONCLUSION AND RECOMMENDATIONS

Ghana produces millions of tons of agricultural waste annually, however farmers are in dire need of nutrients to produce crops on their farms. Composting of this waste can produce organic compost fertilizer which contains enough nutrients essential for plant growth to increase yields. The demand and consumption of organic products is on the increase in the world (Hoefkens, Verbeke, Aertsens, Mondelaers and Camp, 2009; Muhammad, Fathelrahman and Ullah, 2016). Also, organic products are far more expensive than the inorganic products and most Ghanaians are ready to buy it when they have the means (Osei-Asare, 2009) but most Ghanaian farmers are not taking advantage of it. It is concluded that mixing rice husk to chicken droppings in the ratio of 2 parts of rice husk and 2 parts of chicken droppings can produce good compost after 84 days to be used in farming practices with maximum results.

Many foreign firms are entering the free zones area of Ghana to produce and export organic produce to foreign markets in Europe, North America and parts of Asia but peasant farmers are yet to take advantage of the organic produce market (Angko, 2014). The implication is that farmers, especially rice farmers in the country will not be able to access this huge organic product market if they continue to rely on inorganic fertilizers. This means poverty alleviation programmes that are aimed at the poor farmers stand to be missed. The government of Ghana's plant for food and jobs programme stand a chance of entering the world market if farmers can be educated to embark on organic farming to take advantage of these organic product markets. For the government of Ghana's planting for foods and jobs to succeed, there is the need to improve access and adoption of organic inputs like organic fertilizer at affordable prices. The implication of using rice husk and chicken droppings to produce organic fertilizer is that, the huge pile of rice husk and poultry droppings that are dumped in landfills or burnt will no longer take place but rather will be used to enhance the soil for sustainable development. The following recommendations are made:

i. Farmers should be educated to mix rice husk to chicken droppings in the ratio of 2 parts of rice husk and 2 parts of chicken droppings, and compost the materials for 84 days after which the compost would be ready for use in farming practices with maximum results.
ii. The government of Ghana and non-governmental organizations should organize farmers around rice farming communities and educate them on the usefulness of their farm waste-rice husk as raw material for fertilizer production.
iii. Enlightenment programmes should be done by extension officers all over the country to improve the knowledge of farmers on the advantages of organic farming.
iv. The government at all levels (national, regional and local) should educate consumers on the importance of eating organic products. This will increase the demand for these products which will force farmers to use organic fertilizer to produce the crop for local consumption and export.

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