7

Indigenous Fertilizing Materials to Enhance Soil Productivity in Ghana

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1. Introduction

Ghana is divided into six ecological zones namely; Sudan Savannah, Guinea Savannah, Forest Savannah Transition, Semi-Decideous Rainforest, High Rainforest and Coastal Savannah (Figure 1). The Guinea Savannah zone covers the whole of Upper West and Northern regions. It also occupies parts of Uppr East region and the northern part of Brong Ahafo and Volta regions. This zone has a single rainfall season lasting from May to October. Annual rainfall is about 1000 mm. The Sudan Savannah occupies the north-eastern part of Upper East region with an annual rainfall of between 500 – 700 mm. The Forest Savannah Transition lies within the middle portion of Brong Ahafo region, the northern part of both Ashanti and Eastern regions and the western part of Volta region. This zone has a bimodal rainfall with an annual rainfall of about 1200 mm. The Semi-Decideous zone cut across the northern part of Western region through southern Brong Ahafo, Ashanti and Eastern regions. It also occupies the estern part of Volta region and most parts of th Central region. It also has a bimodal rainfall with an annual rainfall of 1400mm.

Most parts of Western region is within the High Rainfall zone. A small part of Central region also falls within this zone. Annual rainfall is over 2000 mm with a bimodal partern. The Coastal Savannah stretches from Central region through Greater Accra to the Votal region. It has only one rainy season of about 600 mm.

1.1 Agriculture productivity

Table 1 shows major crops and the respective areas on which these crops were cultivated in 2007. Due to inappropriate farming practices actual yield per unit area is less than 30% of achievable yield. The trend is similar for most crops. After several interventions including the introduction of improved varieties yield per unit area for most crops is still very low. Soil fertility has been identified as a major factor militating against crop yield. Mineral fertilizers to boost crop production are expensive and sometimes unavailable.

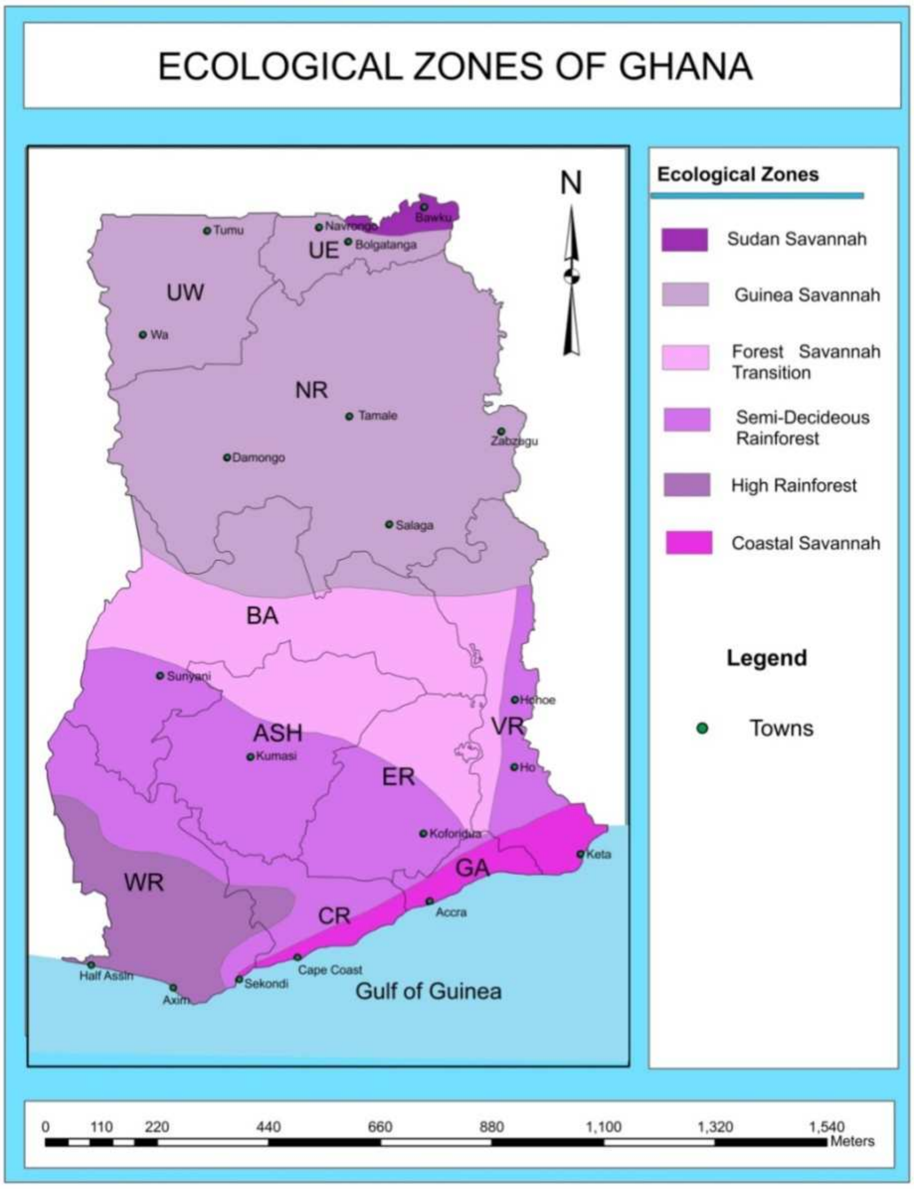


Fig. 1. Ecological zones of Ghana

Crop	Area ('000 ha)	Average Yield (Mg/ha)	Achievable Yield (Mg/ha)	Potential Yield Gap (Mg/ha)
Cassava	886	13.8	48.7	34.9
Maize	954	1.7	6.0	4.3
Rice	162	2.4	6.5	4.1
Yam	379	15.3	49.0	33.7
Plantain	325	11.0	20.0	9.0
Cocoa	1,600	0.4	1.0	0.6

MoFA (2009).

Table 1. Cultivated Area, Average Yield and Potential Yield of Selected Crops in Ghana

2. Status of soil fertility in Ghana

2.1 Major soils

The Ghanaian classification (Brammer, 1962) was equated to the World Reference Base (WRB) classification, ISSS/ISRIC/FAO (1998) by Adjei-Gyapong and Asiamah (2000) as follows:

Savanna Ochrosols (WRB: Lixisols/Luvisols) – These soils occur in northern Ghana and parts of the coastal savanna. They are highly weathered and moderately to strongly acid in the surface soil. Organic matter is low (<15 gkg^{-1} soil). Soil fertility is generally low.

Forest Ochrosols (WRB: Acrisols/Alfisols/Lixisols/Ferralsols/Nitisols/Plinthosols) - These soils occur within the forest zone and parts of the forest-savanna transition. They are deep and highly weathered and are generally moderate to strongly acid in the surface soil. These soils have high organic matter content in the top horizon which may contribute significantly to the phosphorus pool, exchangeable bases and Nitrogen levels.

Forest Oxysols (WRB: Ferralsols/Acrisols) - These occur in the high rainfall zone (south-west of Western Region). These soils are deep and highly weathered but strongly acid (pH<5.0). Organic matter is very high with high potential in N and P supply. P fixation is very high due to the presence of large amounts of Al and Fe oxides.

Groundwater Laterites (WRB: Plinthosol/Planosol) - These soils occur mostly in northern Ghana. They are shallow to plinthite and low in organic matter. Soil fertility is generally poor. They have high P fixation due to the presence of abundant iron concretions.

Parameter	Mean	Range	St. Dev.
pH (water)	4.6	3.7 - 7.4	0.5
Total C (g kg^{-1})	6.10	0.6 - 19	3.0
Total N (g kg^{-1})	0.65	0.1 - 1.6	0.3
C:N ratio	9.3	5.0-14.3	1.4
Available P (mg kg^{-1})	1.5	Tr - 5.4	0.9
Exchangeable K {cmol (+) kg^{-1}}	0.22	0.04 - 1.1	0.17
Exchangeable Ca {(+) kg^{-1}}	2.10	0.53 - 15	1.9
Exchangeable Mg {(+) kg^{-1}}	1.00	0.27 - 5.87	0.27
Exchangeable Na {(+) kg^{-1}}	0.12	0.1 - 0.72	0.11
Exchangeable. Acidity {(+) kg^{-1}}	1.00	0.05 - 1.80	0.48
Clay content (g kg^{-1})	66	40 - 241	39
Silt content (g kg^{-1})	607	347 - 810	107

Number of samples: 90; Source: Buri et al. 2000; Topsoil (0-20 cm)

Table 2a. Mean soil fertility characteristics of lowlands within the Guinea Savannah.

Characteristics of lowland soils: Most lowlands within the Guinea savannah and Semi-deciduous rainforest are mainly inland valleys and river flood plains. Rectilinear valleys occur within the Savannah agro-ecological zone while convex valleys are common within the Forest agro-ecological zone. Concave valleys, however, occur in both zones. Major soil types in these two zones are basically Gleysols and to a lesser extent, Fluvisols. *Volta* and *Lima* series are prominent within the savanna while *Oda, Kakum* and *Temang* series are prominent in the forest zone.

Soil fertility levels as observed for selected parameters are low across locations, particularly within the Savanna zone (Buri et al. 2009). Available phosphorus (P) is the most deficient nutrient in both zones. Soils of the Savanna were also observed to be quite acidic. Exchangeable Cations (K, Ca, Mg, Na) are quite moderate across locations within the Forest agro-ecology but relatively low for the Savannah, particularly Ca. Both total carbon and nitrogen levels, even though low, were comparatively higher for the forest than the savanna zone. To increase yield levels under these conditions the fertility levels of these soils must be improved.

Parameter	Mean	Range	St. Dev.
pH (water)	5.7	4.1 – 7.6	0.89
Organic C (g kg^{-1})	12	3.6 – 36.5	0.58
Total N (g kg^{-1})	1.1	0.30 – 3.20	0.05
C: N ratio	11	4.9 – 14.2	1.26
Available P (mg kg^{-1})	4.9	0.1 – 28.5	5.36
Exchangeable K {(+) kg^{-1}}	0.42	0.03 – 1.28	0.25
Exchangeable Ca {(+) kg^{-1}}	7.5	1.1 – 26.0	5.1
Exchangeable Mg {(+) kg^{-1}}	4.1	0.3 – 12.3	2.6
Exchangeable Na {(+) kg^{-1}}	0.32	0.04 – 1.74	0.26
Exchangeable. Acidity {(+) kg^{-1}}	0.31	0.04 – 1.15	0.29
Clay content (g kg^{-1})	127	41 - 301	8.2
Silt content (g kg^{-1})	502	187 - 770	45.8

Number of samples: 122; Source: Buri et al. 2009. Topsoil 0-20 cm

Table 2b. Mean soil fertility characteristics of lowlands within the Semi-deciduous rainforest

Characteristics of upland soils: Nutrient levels for upland soils are characteristically very low (Tables 3 a, b and c). The soils are generally acidic. Soil pH values for the high rainforest zones are strongly acidic with very low exchangeable cations. Prolonged weathering and leaching under high rainfall regime has resulted in soils with very low pH regimes. In the Semi-deciduous rainforest the soils are relatively richer. Nutrient levels, however, suggest the need for improvement for any profitable production levels to be achieved. In the Savannah zone, nutrient levels are similar to the high rainfall zone. Soil pH values are, however, higher in the Savannah zone. While organic matter and nitrogen levels vary between ecologies, available P is a problem throughout the country. Low total P coupled with high fixation are major factors affecting P availability.

Parameter	Mean	Range
pH (water)	4.1	3.4-5.4
Total C (g kg^{-1})	13.0	3.9-24.3
Total N (g kg^{-1})	1.9	0.7-3.5
Available P (mg kg^{-1})	2.8	0.4-13.6
Exchangeable K {(+) kg^{-1}}	0.13	0.04-0.33
Exchangeable Mg {(+) kg^{-1}}	1.0	0.3-3.3
Exchangeable Ca {(+) kg^{-1}}	1.9	0.5-5.1
Exchangeable. Acidity {(+) kg^{-1}}	4.1	2.1-5.6
ECEC {(+) kg^{-1}}	3.1	0.9-8.1
Base saturation (%)	78	38-98
Sand (%)	-	-
Silt (%)	-	-
Clay (%)	6.1	2.1-18.1

Mean of 30 samples (0-20 cm)

Table 3a. Mean soil fertility characteristics of lowlands within the High rainforest (Western region)

Parameter	Mean	Range
pH (water)	5.5	4.6-6.6
Total C (g kg^{-1})	18.0	13.9-22.3
Total N (g kg^{-1})	1.3	0.8-2.5
Available P (mg kg^{-1})	6.8	2.4-18.6
Exchangeable K {(+) kg^{-1}}	0.18	0.05-033
Exchangeable Mg {(+) kg^{-1}}	2.5	1.5-4.6
Exchangeable Ca {(+) kg^{-1}}	4.9	2.0-10.1
Exchangeable. Acidity {(+) kg^{-1}}	1.5	0.2-3.6
ECEC {(+) kg^{-1}}	8.5	3.8-14.5
Base saturation (%)	85	75-95
Sand (%)	88	80-92
Silt (%)	15	5-21
Clay (%)	9	3-15

Mean of 40 samples (0-20 cm)

Table 3b. Mean soil fertility characteristics of lowlands within the Semi-deciduous rainforest

The inability of farmers to buy adequate amounts of mineral fertilizers to improve their crop yields is a major factor affecting food security. Use of locally available materials for soil improvement is an option that must be fully exploited. Use of these materials (manures, dungs, crop residue, mineral deposits) will significantly improve on the soils ability to sustain higher crop yield.

Parameter	Mean	Range
pH (water)	5.4	4.6-6.6
Total C (g kg^{-1})	12.0	2.9-18.3
Total N (g kg^{-1})	0.9	0.8-1.5
Available P (mg kg^{-1})	4.8	0.4-11.6
Exchangeable K {(+) kg^{-1}}	0.11	0.03-0.23
Exchangeable Mg {(+) kg^{-1}}	1.5	0.8-2.6
Exchangeable Ca {(+) kg^{-1}}	2.9	1.0-5.1
Exchangeable. Acidity {(+) kg^{-1}}	1.1	0.5-2.6
ECEC {(+) kg^{-1}}	5.1	2.8-8.5
Base saturation (%)	88	65-98
Sand (%)	92	82-92
Silt (%)	11	4-21
Clay (%)	7	2-12

Mean of 40 samples (0-20 cm)

Table 3c. Mean soil fertility characteristics of lowlands within the Savannah agro-ecological zone

Table 4 shows the effect of some of these materials (poultry manure, cow dung and rice husk) on rice yield. Sole application of these materials or in combination with mineral fertilizer increased rice yield over the control. In some instances sole application of some of these materials was as good as applying the recommended rate of mineral fertilizer. This clearly shows that the productivity of these poor soils can be improved through the use of locally available fertilizing materials.

Treatments	Potrikrom	Biemso No. 1	Biemso No. 2
Absolute Control	1.7a	2.6a	1.5a
90-60-60 (N-P_2O_5-K_2O) kg/ha (Urea as N source)	7.0d	7.5d	4.0ef
90-60-60 (N-P_2O_5-K_2O) kg/ha (SA as N source)	6.6d	7.3d	3.9def
Poultry Manure (7.0 t/ha)	6.0d	6.4c	3.3bc
PM (3.5 t/ha) +45-30-30 (N-P_2O_5-K_2O) kg/ha (Urea as N source)	6.3d	7.3d	3.7cde
Cattle Manure (7.0 t/ha)	4.5c	6.3c	3.4cd
CM (3.5 t/ha) +45-30-30 (N-P_2O_5-K_2O) kg/ha (Urea as N source)	4.9c	6.2c	3.7cde
Rice Husk (7.0 t/ha)	3.3b	5.5b	2.8b
RH (3.5 t/ha) +45-30-30 (N-P_2O_5-K_2O) kg/ha (Urea as N source)	4.4c	6.3c	3.3c

Source: Buri et al. 2004

Table 4. Effect of organic amendments and mineral fertilizer on paddy yield (t/ha)

3. Fertilizing potential of indigenous materials

Organic waste is produced wherever there is human habitation. The main forms of organic waste are household food waste, agricultural waste, human and animal waste. The economies of most developing countries dictates that materials and resources must be used to their fullest potential, leading to a culture of reuse, repair and recycling. In many developing countries there exists a whole sector of recyclers, scavengers and collectors, whose business is to salvage 'waste' material and reclaim it for further use. Where large quantities of waste are created, usually in the major cities, there are inadequate facilities for dealing with it. Much of this waste is either left to rot in the streets, or is collected and dumped on open land near the city limits. There are few environmental controls in these countries to prevent such practices. In addition, mineral deposits can also be exploited for several purposes including agriculture, particularly soil fertility improvement.

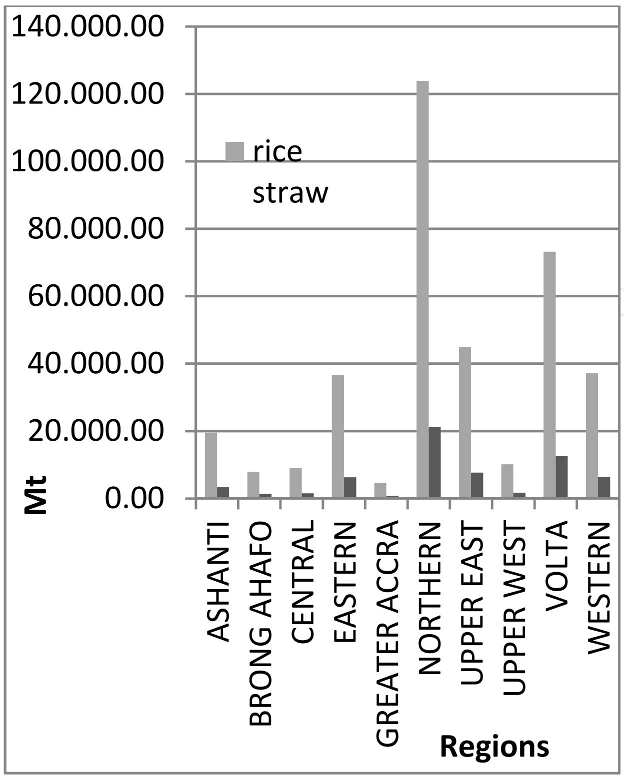
Types of organic waste include: (a) Domestic or household waste (cooked or uncooked food scraps), (b) Agricultural residue (e.g. stover of crops, rice husks, etc.). (c) Commercially produced organic waste (waste generated from schools, hotels, restaurants etc.), (d) Human faecal residue and (e) Animal residue (dung and manures).

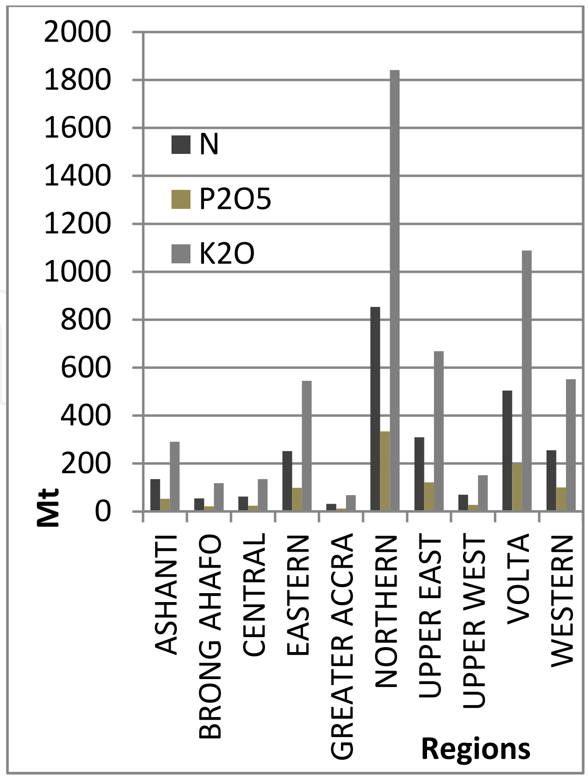
3.1 Plant origin

Large amount of plant waste are annually generated in the form of plant materials. These include maize stover, rice straw, rice husk, millet/sorghum resulting from annual production of these crops. Large amounts of saw dust and wood shavings also come from the wood industry (mostly from timber firms and to a lesser extent from commercial carpenters). Maize stover is normally left on the field after harvest. On the other hand rice is generally brought to a particular spot on the farm for threshing. This results in huge amount of rice straw being put at particular spots on the farm. Rice husk is generated during milling. Large amount of rice husk (about 33 % of paddy weight) is seen in hips close to rice mills in villages or towns. These materials can be used in various forms (direct application, composting, charring or ash) to increase the productivity of the soil.

Rice straw and husk: An estimation of of rice straw and rice husk produced in Ghana in 2007 show that over 366,000 Mt of rice straw and 63,000 Mt of rice husk were produced as waste. Large amount of rice straw (> 120,000 Mt) was produced in the Northern region followed by the Volta (Figure 2A). Upper East region, Eastern and Western regions also produced substantial quantities of rice straw. The trend for rice husk is similar to rice straw but of lower quantities.

Nutrient equivalent of rice straw and husk is presented in Figure 2B. About 2528 Mt of N, 990 Mt of P_2O_5, 5,459 Mt of K_2O (Table 2) is potentially available in these materials. Large amount of calcium and magnesium are also potentially available. Over 50% of these nutrients are potentially available in the large amounts of rice straw and husk produced in the Northern region. These materials can be used as amendments to improve the productivity of lowland soils, for higher grain yields of rice. Particularly the very low organic matter and P status of lowland soils in Northern Ghana (savanna zone) can be improved through effective management of these materials. Total amount of rice straw and husk generated in 2007 is presented in Table 5. These materials can be used to improve both physical and chemical properties of the soil.





Source: Issaka et al., 2010

Fig. 2. Quantity of rice straw and husk (A) and nutrient equivalent (B) for the various regions

Organic source	Quantity (Mt)	N (Mt)	P_2O_5 (Mt)	K_2O (Mt)	CaO (Mt)	MgO (Mt)
Straw	366,975.2	1,834.9	587.2	5,137.7	-	-
Husk	63015.9	693.2	403.3	321.4	352.9	894.8
Total	429,991.1	2,528.1	990.5	5,459.1	352.9	894.8

Table 5. Estimated quantities of rice straw and husk

Saw dust: Generally timber firms are located in the Brong Ahafo, Ashanti and Eastern regions. Some can also be found in the Central and Western regions. Large hips of saw dust can be located on the out skirts of towns or cities where these factories are located. Saw dust constitute a good source of fertilizing material when properly managed.

3.2 Animal origin

Animal waste that can be classified as fertilizing materials include, poultry manure, cow dung, manures from sheep, goats and pigs. Human excreta is another source of fertilizing material. The amount of cow dung produce annually is far larger than poultry manure (Figure 3). Cattle are mostly reared in Northern Ghana (Northern, Upper East and Upper West regions) and hence large amounts of cow dung are obtained from these areas. The three regions together produce over 1.2 million Mt of cow dung annually. On the other hand poultry rearing is more concentrated in Greater Accra and Ashanti regions and like cow dung each of the regions produce some amount of it.

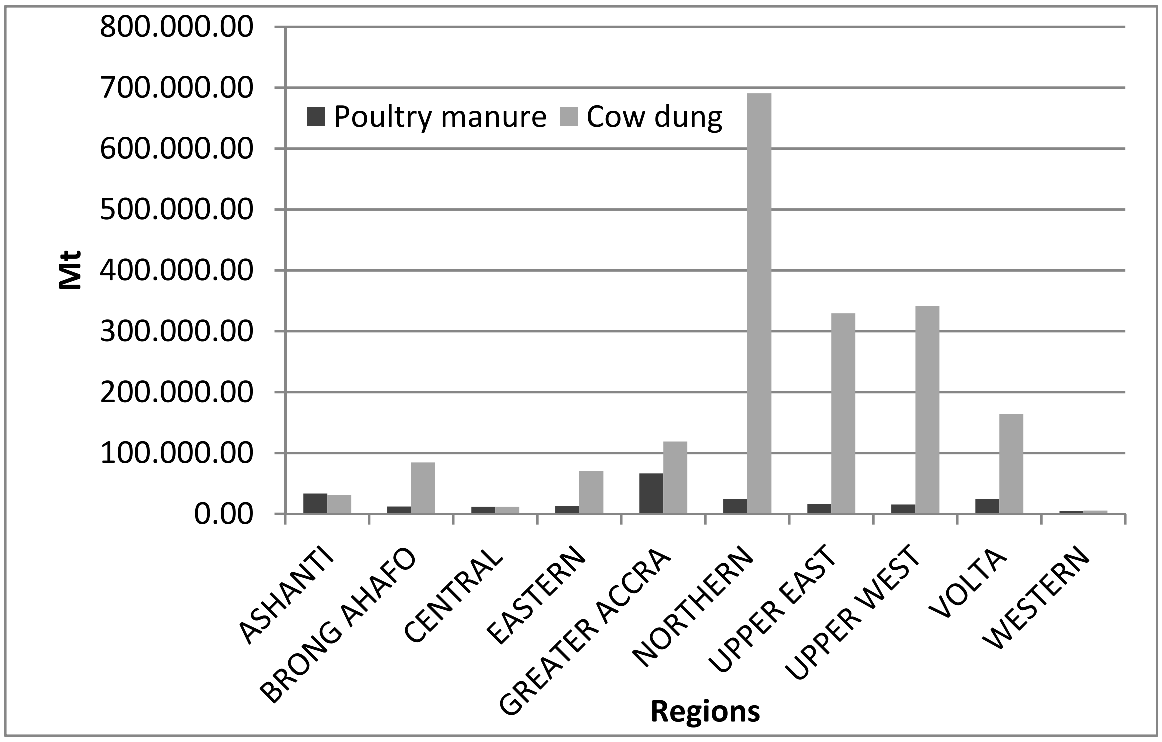


Fig. 3. Quantities of poultry manure and cow dung for the various regions

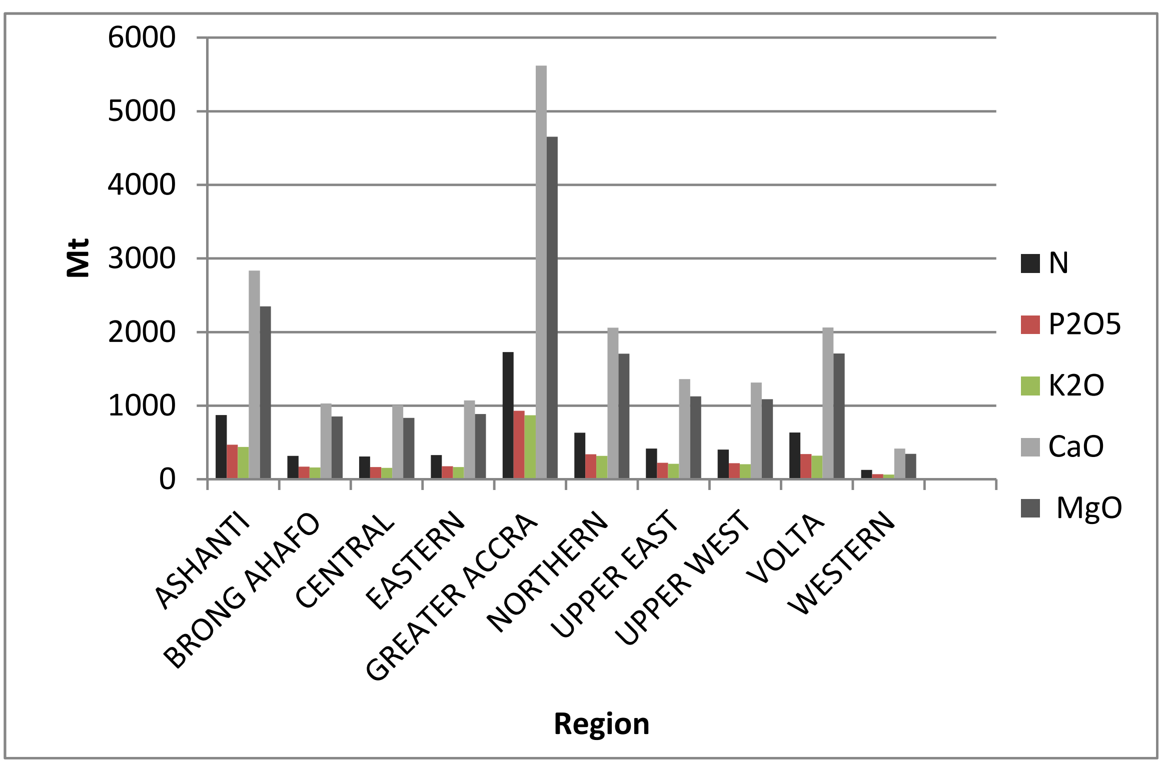


Fig. 4. Nutrient equivalent of poultry manure for the various regions

Nutrient equivalent of poultry manure is presented in Figure 4. Calcium and magnesium content of poultry manure is high. Addition of calcium enriched food materials into poultry feeds especially layers is the most possible reason. Poultry manure is a very good material that may even improve the pH of the soil when applied in large quantities. The manure contains all the major nutrients. These materials can be used to improve the productivity of soils in the forest and coastal Savanna zones.

Figure 5 shows nutrient equivalent of cow dung. Cow dung contains all the major nutrients while the urine is very rich in N and K. Provision of beddings for the cattle results in an improved material since the urine is absorbed by the beddings. Cow dung will increase crop yield significantly especially the very poor soils in the Savanna zone.

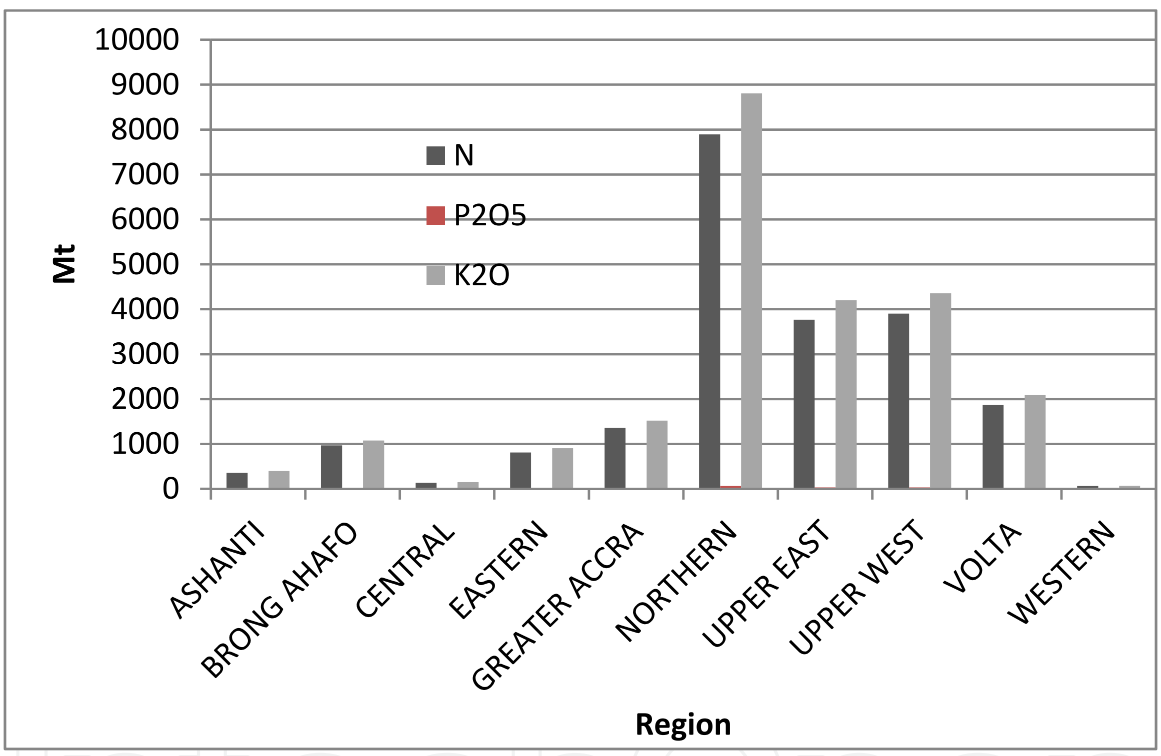


Fig. 5. Nutrient equivalent of cow dung and urine for the various regions

Sheep and goats are reared throughout the country. Northern and Volta regions rear a lot of sheep and goats while in the Upper West region a lot of sheep are reared. Generally these animals are reared throughout the country. Large amount of sheep and goat manures are produced annually (Figure 6). Quantity of manure produced is directly related to number of animals in these regions. Sheep and goat manure contain high amount of nitrogen. Manure produced by these animals is normally mixed with the urine resulting in the relatively high amount of nitrogen in their manure.

Generally about 3.2 million Mt of manure was produced by animals in 2007 (Table 6). This amount of manure can reduce the amount of money spent on mineral fertilizer if most of it is used in crop production.

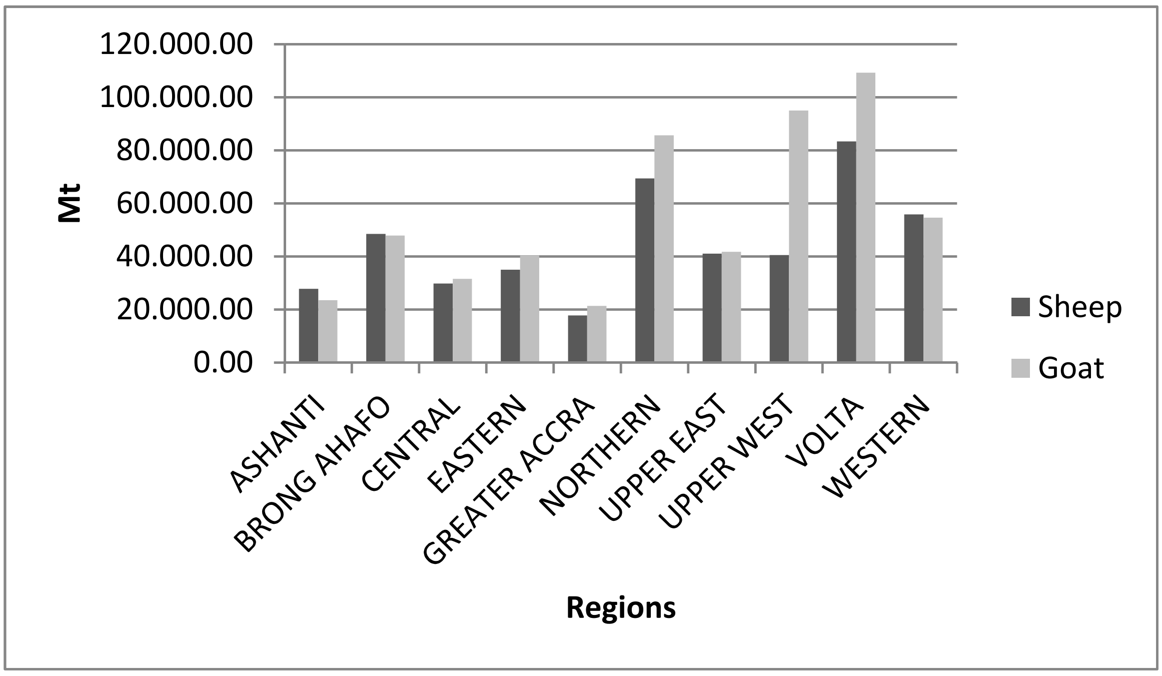


Fig. 6. Quantities of sheep and goat manure for the various regions

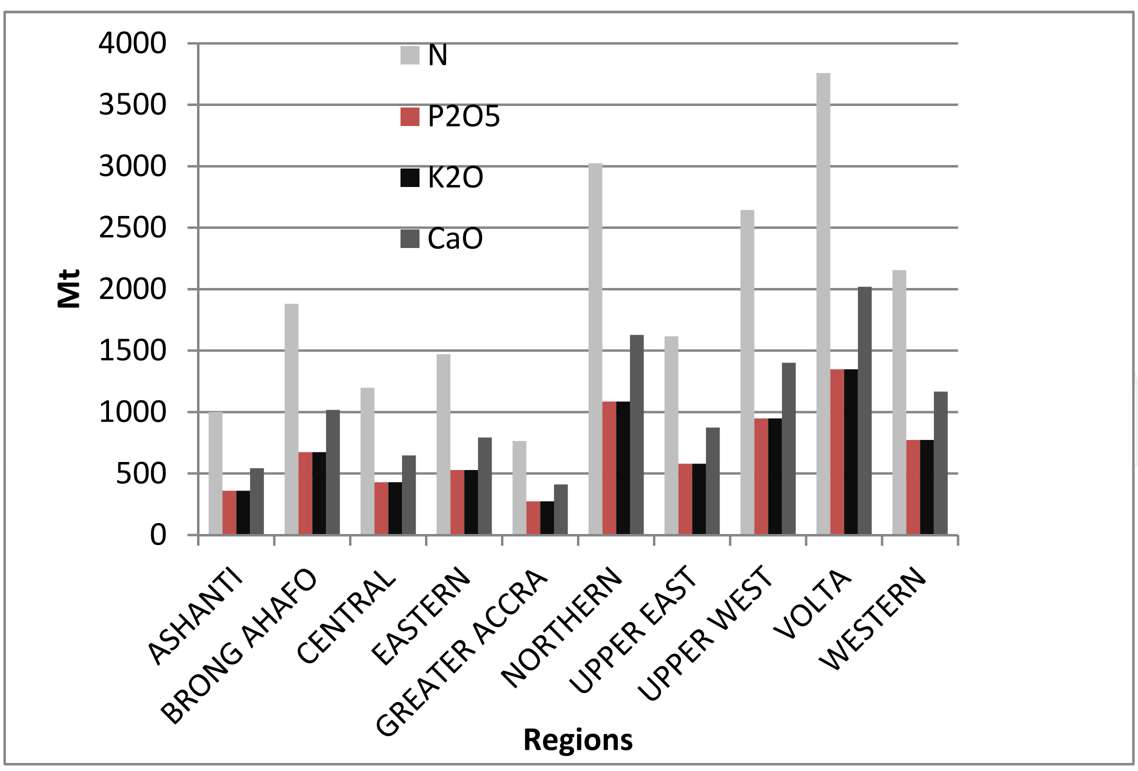


Fig. 7. Combined nutrient equivalent of sheep and goat manure

Type	Q'ty of manure/yr Mt	Nutrient content (Mt)				
		N	P_2O_5	K_2O	CaO	MgO
Poultry	222,228.0	5,777.9	3,111.2	2,911.2	18,778.3	15,556.0
Cattle	1,848,798.0	20,706.5	31,614.4	8,874.2	14,420.6	127,012.4
Sheep	449,388.0	8,763.1	3,145.7	3,145.7	4,988.2	-
Goat	551,354.4	10,751.4	3,859.5	3,859.5	5,513.5	
Pig	118,281.9	2,696.8	2,152.7	2,129.1	378.5	-
TOTAL	3,190,050.3	48,695.7	43,883.5	20,919.7	44,079.1	142,568.4

Table 6a. Quantity and fertilizer equivalent of animal manures

Region	Q'ty of urine/yr Mt	N	P_2O_5	K_2O
Cattle	1,746,087.0	21,127.65	174.61	23,572.17
Sheep	855.0	12.569	0.428	16.758
Goat	1049.0	15.42	0.525	20.560
Pig	294.6	1.119	0.295	2.917
TOTAL	1,748,285.6	21,156.8	175.9	23,612.4

Table 6b. Urine and total nutrient content

A study of quantity of human excreta produced in parts of Accra and Kumasi show that large amount of the material is available and a very good source of amendment for soil improvement (Table 7). Treatment and management of human excreta is generally poor and require some attention.

Location	Quantity Disposed/yr* (Mt)	Nitrogen content/yr (Mt)	P_2O_5 content/yr (Mt)
Accra	292,000	586.04	17.23
Kumasi	54,750	109.88	3.23
Total	346,750	695.93	20.46

Issaka et al 2010

Table 7. Potential available nutrients from human excreta in parts of Accra and Kumasi in 2007

4. Agro-minerals and rocks

Large deposit of limestone and dolomite are found in several parts of the country (Table 8). Mining of some of these minerals will support the agriculture sector of the economy. The very low levels of basic cations need to be significantly raised for the application of Nitrogen, Phosphorus and Potassium fertilizers to be effective and efficient. Basic slag is a good source of P (Table 9) and can be harnessed to improve available P in our soils for better crop production.

Deposit	Type	Deposit (million tons)	CaO and MgO contents (%)	Lime-Potential quantity (million tons)
Akuse region	Shells	1.3	53.5 (0.65)	0.7
Tano	Limestone	1000		
Nauli area	Limestone	400	48.7-52 (0.57-1.84)	194.8
Nauli deposit	Limestone	23	48.9 (1.04)	11.3
Bongo Da	Limestone	15	40.0-49.3 (1.2-4.2)	6.0
Bongo Da	Dolomite	23-30	30.8-36 (12.1-19.0)	7.1
Bupei Upper horizon	Limestone	6		
Bupei Lower horizon	Dolomite	144	29.3-31 (17.5-19.2)	42.2
Oterpolu	Limestone	8-10	38.3 (3.65)	3.1
Po river	Limestone	1.5		
Daboya	Dolomite	0.7		
Total				>265.2

Adapted from Kesse (1985, 1988) cited by Owusu-Bennoah, 1997. Content of MgO in parenthesis.

Table 8. Lime resources of Ghana

Steel Industries	Capacity Mt Steel/yr	Actual Production Mt Steel/yr	Basic Slag Produced/yr* Mt	Quantity of P_2O_5 Produced/yr Mt
Tema Steel Complex	30,000	4500	675	60.75
Ferro-aibric Limited	15000	9000	1350	121.50
Total	45,000	13,500	2,025	182.2

*Adapted from: Owusu-Bennoah, 1997. * Basic slag is 15% of steel produced and contains 9% P2O5*

Table 9. Annual production of basic slag in Ghana

5. Uses of indigenous materials in the various ecological zones

Plant Material: Even though there are many sources of plant materials emphasis will be on rice straw, rice husk and saw dust.

Rice straw is generated on rice farms and is usually burnt during or before land preparation. About 40 percent of the nitrogen (N), 30 - 35 percent of the phosphorus (P), 80 - 85 percent of the potassium (K), and 40 - 50 percent of the sulfur (S) taken up by rice remains in vegetative plant parts at crop maturity (Dobermann and Fairhurst, 2002). Burning causes almost complete N loss, P losses of about 25%, K losses of 20%, and S losses of 50 – 60%. The amount of nutrients lost depends on the method used to burn the straw (Dobermann and Fairhurst, 2002). More losses occur when straw is burnt under windy conditions since most of the ash will be blown away. Thus, huge amount of nutrients are lost annually due to poor management of rice straw. Proper management of this material will greatly improve soil fertility especially in the savanna areas where organic matter is very low. Rice husk may be used as poultry and pig feed but is hardly used as amendment hence all the nutrients in the materials is lost. In Ghana saw dust is normally treated as waste. The material may be used as landfills, deposited in the out skirt of the towns/cities and burnt or left to decompose. Generally saw dust decomposes very slowly and may pose a problem when applied directly on the field.

Animal manure: Poultry manure is on high demand and farmers are unable to get enough of it. Formerly huge piles of poultry manure could be seen by the side of roads close to poultry farms. Farmers could go for the material free of charge. The story is now completely opposite. Farmers have to pay in advance (including cost of transportation) before the manure is conveyed to the field. The effect of poultry manure in the farming industry is only significant in the forest zone (especially Ashanti and Eastern regions) and the coastal savanna zone (GT Accra).

Cow dung is a material highly cherished by rural dwellers in the Upper East region. Cow dung is used for crop production, as a binding agent for plastering houses, for cooking (fuel) and to a lesser extent for trapping termites to feed chicks. Unlike poultry manure the material is not sold and therefore not easy to obtain. In the Upper West region cow dung is not valued. Farmers consider the material to be too heavy and bulky to carry to the field (farms are generally far from home). The story is mixed in the Northern region were farms are also located far from the homes. However, some areas in this region have started making good use of this material. This is in contrast to the Upper East region where most farms are close to the house. In the forest zone cow dung is scarcely used for crop production. Some of it is, however, used in crop production in the coastal savanna zone.

Sheep and goat manures are used widely in the Upper East region. Both the dung and urine are normally mixed resulting in high nitrogen content of the manure. Inclusion of litter (grasses or plant residue) results in the production of farm yard manure. In other parts of the savanna zone the manure is scarcely used. Some amount of it is used in the Volta and Western regions.

Human excreta are used in parts of the Northern region. Farmers may hire trucks to collect the effluent which is deposited on their fields in its raw form. This practice is rather unhygienic. In parts of Kumasi, near Kwame Nkrumah University of Science and Technology, human excreta is allowed to decompose. Farmers are then given the option to collect the decomposed material to their fields. Patronage is however low.

6. Management of indigenous materials

Plant materials (saw dust, rice straw, rice husk etc) can be decomposed, charred or even ashed so as to make the material more user friendly and the nutrients more available to plants. Within the farm it should be possible to decompose rice straw before application.

Rice husk which is normally out of the farmers reach can be carbonized (material becomes easier to transport in this form) before application. The material can also be ashed (this may be environmentally unfriendly) before transporting to field. Ashed rice husk or straw has a pH of over 11.0 and hence can be used to improve the rather acidic soils that are common in Ghana. Decomposed saw dust is generally a very good material. It takes more than 6 months to get the material well decomposed. The material, however, can easily be charred or ashed.

7. Conclusion and recommendations

A wealth of indigenous materials are available in Ghana. These materials can be used to significantly improve the fertility of the soil. Some of these materials include rice straw and husk; saw dust, poultry manure, cow dung, goat and sheep manure, and human excreta. It is strongly recommended that materials of plant origin should be composted or charred before usage. Human excreta need to be composted before it is used.

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