Nutrient Availability of Organic Manure for Arable Crop Cultivation in the Kano Close Settled – Zone Kano State, Nigeria

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***Abstract*:** Organic manure has been the single most important agricultural input for the smallholder farmer in the Kano Close Settled Zone. It has been proved to provide sustainability to the farming system. In this high density farming system, eight major types of organic manure were sampled and analysed in the lab for the basic nutrient elements. It was found that donkey manure has the highest concentration of the major nutrient elements especially Nitrogen, Phosphorus Potassium and Organic carbon. This was followed by small ruminants (sheep and goats), cattle manure and poultry manure, while ash and pit latrine manures are worst in terms of major nutrient elements nonetheless Calcium and Sodium are highest in ash manure as expected. The trend of potassium (K) is different from other major nutrient elements, though highest in donkey manure but is worst in pit latrine, compound sweeping and poultry manure. It is further suggested that analysis be made for the estimation and quantification of these nutrient per a bag/pannier of these manures.

Keywords— organic manure, farming system, nutrient concentration, Kano close settled zone, Nigeria

I. INTRODUCTION

Manure is any substance that is applied on the land/soil to supply plant nutrients or amends soil fertility, and it can be organic or inorganic material. The inorganic fertilizer is industrial and chemical synthesed material and thus very costly to the smallholder farmer in northern Nigeria. However the organic manure are generated locally and thus are varied in types and sources, that make them to have different nutrients concentration.

Organic manure has been in used for centuries by smallholder farmer in northern Nigeria and it use for crop production was proved to be sustainable in the Kano close-settled zone (Harris, 1995 and Yusuf, 2001). The Kano close-settled zone (KCSZ) in northern Nigeria is the most intensively farmed area in the semi-arid region of West Africa. Organic manure plays a key role in the sustainability of crop production. (Harris and Yusuf, 2001). The importance of organic manure to the maintenance of soil fertility in low input farming systems has been emphasized in literature (Powell et. al, 1995; FAO, 1998). Organic manure provides a low cost supply of nutrients and organic matter with which farmers can improve soil fertility. The application of manure in the farmlands is known to improve soil water holding capacity, Cation exchange capacity, and soil structure (Harris and Bache, 1995; Harris and Yusuf, 2001). Manure is also a source of Nitrogen, Phosphorus, Potassium and a range of micronutrients (Weight and Kelly, 1999). Animal manure is an integral component of soil fertility management practices in semi-arid West Africa because soils in this region are deficient in nutrients, particularly Phosphorous (P) and Nitrogen (N) (FMANR, 1990). It is most popular in literature that organic manure augments soil organic matter content, raises soil pH, improves nutrient exchange and water holding capacity of soils and when sufficient quantity is applied on a continuous basis, might permit sustainable crop production (Mokwunye, 1980; Powel et. al; 1995; Harris and Yusuf, 2001).

In the Kano close settled zone, there is the integration of crops and livestock as a system which provides a source of manure for the farmer, supplies fodder to feed livestock and brings the management of both resources (fodder and manure) under the farmers control. Farmers manage the resources to ensure maximum recycling of nutrients within the farming system and so enhance soil fertility. Thus effective and efficient management of manure is necessary to maximize the benefits of integrated farming systems and ensure the maintenance of soil fertility. The issue of loss of nutrients per hectare is well established (Smalling, 1993). However the nutrient content of organic manure applied by the farmer is not accurately known as per the type of crop grown.

Some scientists are of the view that, crop cultivation results in the decline of soil quality relative to nutrient exploited (Weight and Kelly, 1999). Estimate for 38 countries in Sub-Sahara Africa (SSA) suggests that annual loss of nutrient per hectare during the 1980's was 22kg of N, 2kg of P, and 15kg of K (Weight and Kelly 1999). Then this is termed as soil mining (Smalling, 1993) and this can lead to loss of soil organic matter, with subsequent decline in soil nutrients,

water holding capacity and deterioration of soil macro-structure and infiltration (Usman, 2000).

The basic knowledge known on the soils of Kano close settled zone is that it is ferruginous tropical soils, it is acidic and low in cation exchange capacity (CEC) and also generally low in inherent soil fertility (Yusuf, 2001). They are also very susceptible to loss of nutrient under crop cultivation (Weight and Kelly, 1999; Harris and Bache, 1995). The soils are inherently low in organic matter, CEC and many other nutrient elements. However despite the application of organic manure for centuries, this basic assumption remains not clear. Thus the knowledge of nutrient concentration of organic manure being applied is necessary so as to understand the type that can be applied to ameliorate the problem of nutrient depletion.

Therefore, there is every need to further investigate deeply into this adaptive strategy of traditional methods of soil fertility improvement by the smallholder farmers in northern Nigeria especially the use of organic manure. However the different nutrient content has to be ascertained. This will help towards better intensification of the production system in the area. Generally, different manures have different levels of nutrient elements. There is every need to essentially know the nutrient elements contained in these manures with the view to ascertaining the basic requirement of the staple crops in this locality. Therefore the objectives of this paper is to examine the nutrients content of the common, basic organic manures used in Kano close settled zone for staple crop production.

II. DESCRIPTION OF THE STUDY AREA

The study area comprises of three villages selected as representative of Kano Close Settled Zone, where the rural population density is considered to be very high by tropical African standard (Mortimore, 1999). Kano close settled zone comprise the rural areas surrounding Kano city. It covers a radius of 45km from Kano wall-city. Three Local Governments were chosen and in each Local Government, one village was selected. These include Sarai in Dawakin Kudu Local Government Area to the south, Maisar Tudu in Gezawa Local government Area to the East and Maigari in Rimin Gado Local Government Area to the West (Figure 1).

III. MATERIAL AND METHODS

Three typical rural-farming villages in the Kano Close-Settled Zone were selected from different directions for interviews, and the collection of manure samples. These include Sarai in Dawakin Kudu Local Government Area; Maisar Tudu in Gezawa Local government Area and Maigari in Rimin Gado Local Government Area (Figure 1). These villages were chosen because they represent typical rural farming communities of Kano Close-Settled Zone in their respective locations.

Ten (10) farmers were purposefully selected in each of the three village areas and this was followed by Participatory Rural Appraisal (PRA). The PRA helped to check and to identify the typical manure types as consensus in the area. Each typical type of manure was brought to PRA team and samples collected for lab analysis. The procedure was to identify one typical manure type; put in a large bowl; mixing it vigorously, then a sub sample of about half a kilogram ($^1/_2$Kg) was collected for lab analysis.

IV. LABORATORY ANALYSIS

The parameters determined for each manure includes the following: Total Nitrogen (N), Phosphorus (P) Organic carbon (OC), and Exchangeable Sodium (Na), Potassium (K), Calcium (Ca) and Magnesium (Mg). These are the basic nutrient elements required by typical arable crops in the area to bring about reasonable growth and productivity. Most of the stable crops in the area are sorghum, millet, maize as food crops and groundnut and cowpea for cash. Standard laboratory procedures were used for the analysis.

V. RESULTS AND DISCUSSION

VI. Types of Organic Manure in Kano Closed Settled Zone

Table 1 summarises the types of manure found and sampled in the three villages in the Kano Close Settled Zone. Their local names and English equivalent is given and description as consensus during the PRA. There are eight clearly defined manure types. They are mainly based on the sources from which they are generated. Most of them are generated from domestic animals kept by the smallholder farmer with exception of three: pit latrine, compound sweepings and ash manures.

Also the two principal crops recommended by the manure type are given. It can be seen that the major stable crops grown in the area are sorghum, millet and maize which form the basic food crops in the area.

VII. Organic Manure Types and Nutrient Content

From the lab analysis table 2 was drawn which present the eight types of manure found in these areas as small ruminant (goat & sheep), cattle dung, poultry (chicken), pit latrine, compound sweepings, ash, horse and donkey manures. The average, standard deviation and coefficient of variation of the 3 samples collected from the three villages were computed under the seven basic parameters tested as Nitrogen %, Organic carbon %, Phosphorus % and the four exchangeable bases (Ca, Mg, K and Na in me/100g).

There are high coefficients of variation in all the seven parameters of all the 8 manure types with the exception of horse and donkey manures. This indicates that serious variations exist in the samples of manure collected among the three villages. This is because the small holder farmer management of manure differs and also there exists some mixing of some manure with other types. However this does

not nullify the evidence that all the manures have higher concentration of these elements as can be seen in Table 2.

VIII. Concentration of Nitrogen, Phosphorus and Potassium (N P K) in the Organic Manures

Figure 2 depicts the graphical presentation of the basic macro nutrient elements required by the major crops grown in the area, N P K. Their concentrations among the eight manure types shows that Nitrogen is highest in donkey manure, more than in small ruminant, cattle and poultry manures. The trend is almost similar with phosphorus. However the least in Nitrogen and phosphorus are ash and pit latrine manures. This is not surprising as ash and pit latrine may not contain very high amount of these elements.

Nitrogen and Phosphorus are essential for plant growth and the major sources are from decomposed organic matter which is the main part of donkey manure. N and P are macro elements together with potassium (K) are required by crop plants in relatively larger amount, more than 1 ppm of the dry matter of a crop plant (White, 1997)

The concentration of potassium (K) among the 8 manure types is slightly different from Nitrogen and Phosphorus. Though it is highest in donkey and horse manures, it is also relatively high in Ash and small ruminant manures. It is least in pit latrine and compound sweepings. Potassium differ possibly because unlike N and P , it is normally in ironic form (K^+) in soil solution like Ca^{++} and Mg^{++}, and are taken up by plants from the soil solution as cations.

IX. Organic Carbon in the Manures

Organic matter is the decomposed remains of plants and animals and micro-organisms in the soil. It is generally very little in the soil taking about 2 to 5% of the soil. However only about 58% of Organic matter in the soil constitutes organic carbon (Weight et al, 1999). From figure 3 it is basically found that there are higher quantity of more than 2% in all the manure types with the exception of ash (0.68%) and pit latrine (0.82%) manures. And for donkey manure it is over 3.3% and this followed by cattle manure (2.73%).

X. Exchangeable Bases ($Ca^{++,}$ Mg^{++} and Na^+) in The Organic Manures

Many essential plant nutrients exist in the soil as cations. Examples are potassium (K+), calcium (Ca2+), magnesium (Mg2+), and Sodium (Na+) and are termed as exchangeable cations/Bases. From the graph in figure 4 it can be seen that for calcium, is obvious that ash manure has the highest concentration of 83.33 me/100g which is about 2 to 3 times more than in most of the manure types. Ash from domestic cooking obviously has very high Ca and Na as can be seen in the graph. The least is the compound sweepings which according to the local people is the most variable type of manure.

Magnesium is relatively low in all the manures compared to other exchangeable bases; however it is fairly high in ash and horse manures though the difference is not much with small ruminant and donkey manures. The least is pit latrine which is not surprising as this type of manure is low in most of the elements tested. For Exchangeable Na^+ which is not a proffered element for crop cultivation, the concentration is fair among the eight types of manure with slightly rise in ash manure.

X1. CONCLUSIONS

The eight manure types analysed in the lab have relatively satisfactory concentration of the basic nutrient elements. However manure drives from donkey proves to be the best with highest concentration of N, P, K and Organic carbon. This followed by sheep and goat (small ruminant) manure, cattle and poultry manure. Surprisingly pit latrine and ash manures are worse in terms of nutrient concentration. This concurs with the views of most of the local people that pit latrine and ash are not good manures for crop production. It is recommended that further critical analytical research be conducted to analyse and measure the quantity of these nutrients per kilogram or *mangala* (pannier). This will allow understanding exactly the amount of nutrients applied when a known quantity of a particular type of manure is applied in the farm.

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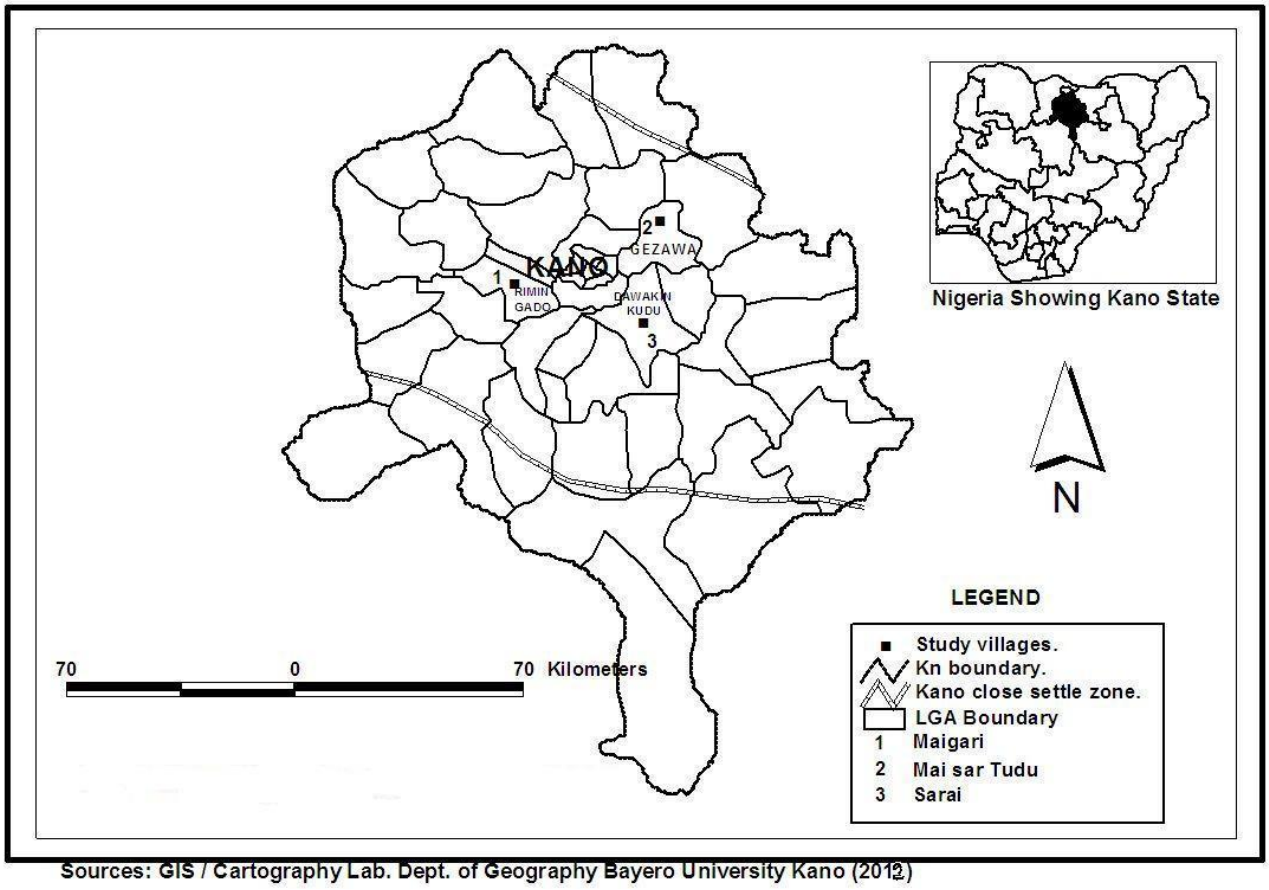

Figure 1. Kano State Showing the Study Villages in Kano Close-Settled Zone.

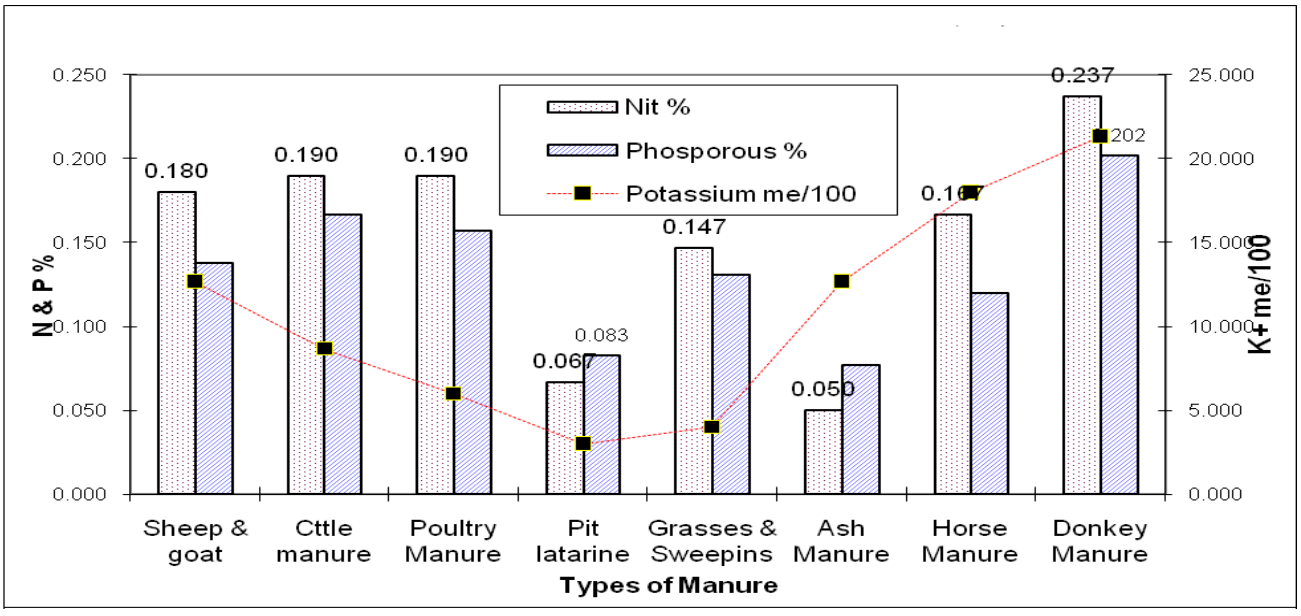

Figure 2. NPK Concentration in different types of Manure

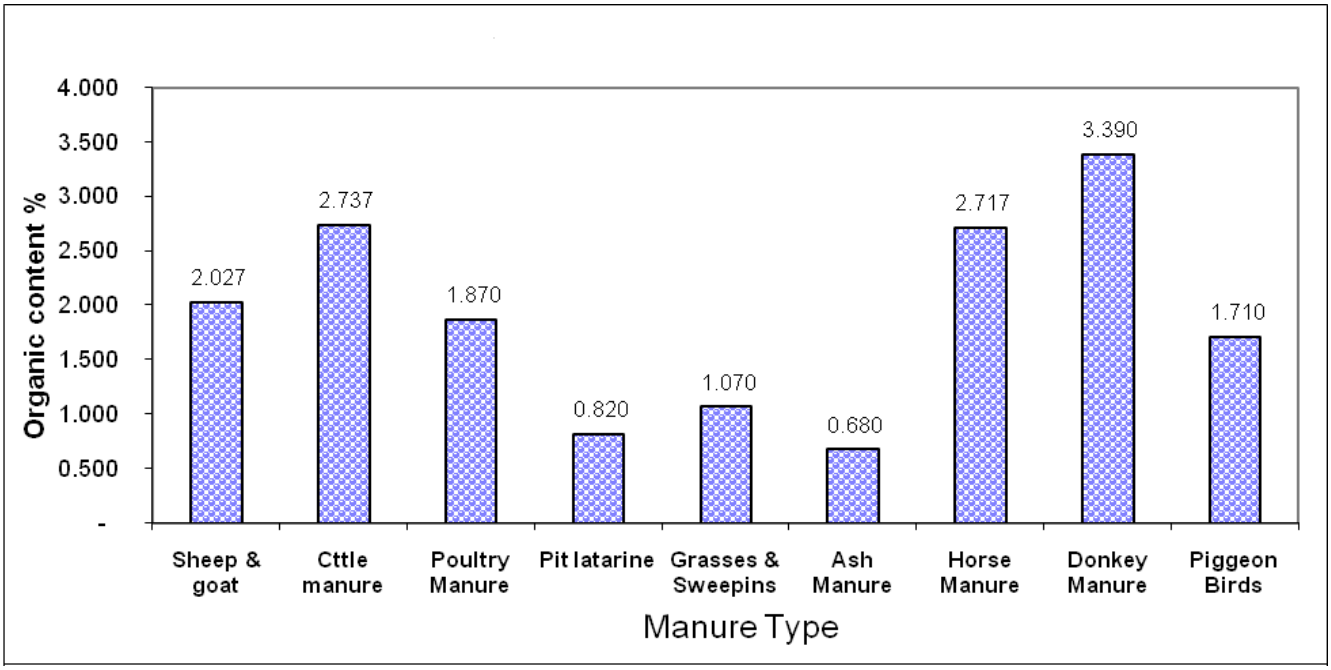

Figure 3. Organic Carbon content (%) in different types of manure

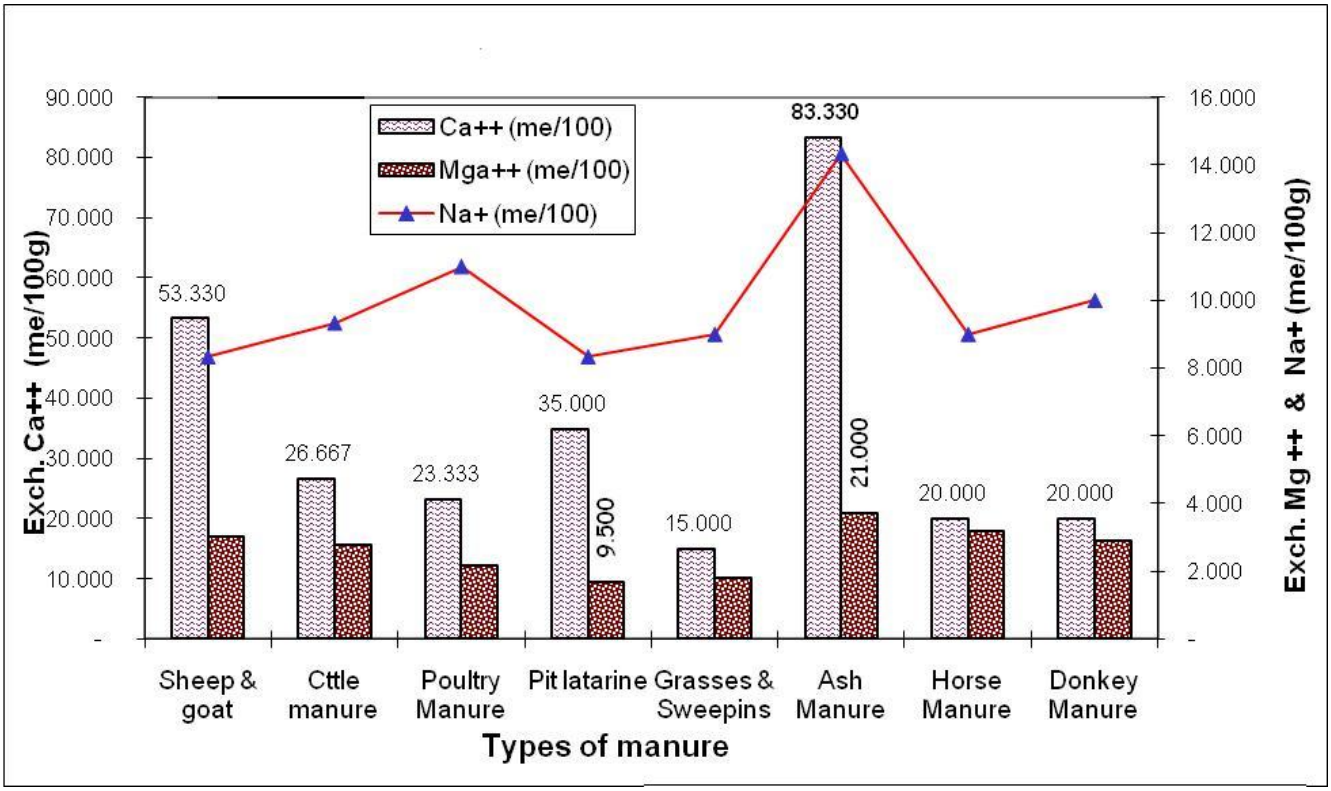

Figure 4. Exchangeable Ca^{++}, Mg^{++} and Na^{+} in different types of manure

Table 1. The Different types of Manure in the Kano Close-Settled Zone

S/No	Type of Manure	Local name	Description	Recommended crops
1	**Small ruminant Manure**	Takin Kananan Dabbobi	Small ruminant manure (sheep & goat) tethered in pen compost; of small ruminant droppings	1. Sorghum 2. Millet
2	**Cattle dung manure**	Takin shanu/ Kandilo/ Bilade	Cattle manure in their pen. This is mostly composed of cattle droppings. Mixed and decomposed with little left over weeds.	1. Sorghum 2. Millet
3	**poultry manure**	Takin kaji/Baru/ Tsuntsaye	Poultry manure from poultry house; mostly from domestic birds; chicken. Generated in poultry house.	1. Onion 2. Vegetables
4	**Pit latrine manure (night soil)**	Takin masai	Household laterine; evacuated after some times	1. Sorghum 2. Maize
5	**Grasses and compound sweepings**	Takin bola	This is the combination of grasses and refuse around the house. It may contain some animal droppings and ashes.	1. Sorghum 2. Groundnut
6	**Ashes manure**	Takin toka	Obtain from household fuelwood/ashes, burnt grasses and stalks.	1. Millet 2. Onion
7	**Horse manure**	Takin doki	Compost of horse droppings in its pen with some left over feeds.	1. Sorghum 2. Millet
8	**Donkey manure**	Takin jaki	Compost of donkey droppings in its pen with some left over feeds.	1. Sorghum 2. Millet

Source: Field work, 2012

Table 2 Manure Types and Nutrient Concentration

Type of Manure	**No of Sample**		**Org. /Cart**	**Nitrogen**	**Ca++**	**Mg++**	**K+**	**Na+**	**P(%)**
			%	%	me/100g	me/100g	me/100g	me/100g	%
Small ruminant (Sheep & Goat) **1**	3	**Average**	**2.027**	**0.180**	**53.333**	**17.000**	**12.667**	**8.333**	**0.138**
		s.d.	1.112	0.105	32.146	8.718	7.638	3.786	0.071
		cv%	**54.8**	**58.5**	**60.3**	**51.3**	**60.3**	**45.4**	**51.2**

Type of Manure	**No of Sample**		**Org. /Cart**	**Nitrogen**	**Ca++**	**Mg++**	**K+**	**Na+**	**P(%)**
			%	%	me/100g	me/100g	me/100g	me/100g	%
Cattle Manure **2**	3	**Average**	**2.737**	**0.190**	**26.667**	**15.667**	**8.667**	**9.333**	**0.167**
		s.d.	0.753	0.053	20.817	1.528	1.155	1.155	0.072
		cv%	**27.5**	**27.9**	**78.1**	**9.8**	**13.3**	**12.4**	**43.4**

Type of Manure	**No of Sample**		**Org. /Cart**	**Nitrogen**	**Ca++**	**Mg++**	**K+**	**Na+**	**P(%)**
			%	%	me/100g	me/100g	me/100g	me/100g	%
Poultry Manure (Chickens) **3**	3	**Average**	**1.870**	**0.190**	**23.333**	**12.333**	**6.000**	**11.000**	**0.157**
		s.d.	1.487	0.115	15.275	4.509	4.583	5.196	0.073
		cv%	**79.5**	**60.7**	**65.5**	**36.6**	**76.4**	**47.2**	**46.3**

Type of Manure	**No of Sample**		**Org. /Cart**	**Nitrogen**	**Ca++**	**Mg++**	**K+**	**Na+**	**P(%)**
			%	%	me/100g	me/100g	me/100g	me/100g	%
Pit Latarine (Night Soil) **4**	3	**Average**	0.820	0.067	35.000	9.500	3.000	8.333	0.083
		s.d.	0.050	0.006	25.333	0.500	1.000	0.577	0.003
		cv%	**6.1**	**8.7**	**71.4**	**5.3**	**33.3**	**6.9**	**3.0**
Type of Manure	**No of Sample**		**Org. /Cart**	**Nitrogen**	**Ca++**	**Mg++**	**K+**	**Na+**	**P(%)**
			%	%	me/100g	me/100g	me/100g	me/100g	%
Grasses & Compound Sweepings **5**	3	**Average**	1.070	0.147	15.000	10.333	4.500	9.000	0.131
		s.d.	0.220	0.055	5.000	0.577	0.500	1.000	0.031
		cv%	**20.6**	**37.6**	**33.3**	**5.6**	**11.1**	**11.1**	**23.7**

Type of Manure	**No of Sample**		**Org. /Cart**	**Nitrogen**	**Ca++**	**Mg++**	**K+**	**Na+**	**P(%)**
			%	%	me/100g	me/100g	me/100g	me/100g	%
Ash Manure (Domestic) **6**	3	**Average**	0.680	0.057	83.333	21.000	12.667	14.333	0.077
		s.d.	0.149	0.021	56.862	11.533	13.279	7.767	0.012
		cv%	**22.0**	**36.7**	**68.2**	**54.9**	**104.8**	**54.2**	**15.1**

Type of Manure	**No of Sample**		**Org. /Cart**	**Nitrogen**	**Ca++**	**Mg++**	**K+**	**Na+**	**P(%)**
			%	%	me/100g	me/100g	me/100g	me/100g	%
Horse Manure **7**	3	**Average**	2.717	0.167	20.000	18.000	18.000	9.000	0.120

		s.d.	0.245	0.025	0.000	3.000	0.000	1.000	0.010
		cv%	**9.0**	**15.1**	**0.0**	**16.7**	**0.0**	**11.1**	**8.3**

Type of Manure	**No of Sample**		**Org. /Cart**	**Nitrogen**	**Ca++**	**Mg++**	**K+**	**Na+**	**P(%)**
			%	%	me/100g	me/100g	me/100g	me/100g	%
Donkey Manure **8**	3	**Average**	3.390	0.237	20.000	16.333	21.333	10.000	0.202
		s.d.	0.220	0.072	0.000	2.517	3.512	2.000	0.039
		cv%	**6.5**	**30.6**	**0.0**	**15.4**	**16.5**	**20.0**	**19.03**