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Livestock manures and compost production and use in Uganda

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Abstract

Agricultural research in Uganda started around 1898. However, research on manures came into light after 1903 when commercial cotton varieties were introduced in the country. It was after the cotton introductions that declining soil fertility was considered a serious problem. Under the Uganda conditions, the use of artificial fertilisers was hampered by their high cost attributed to heavy freight charges due to geographical position. Secondly, cotton was grown entirely by the peasant farmer who was extremely unlikely to adopt use of any form of mineral fertilisers. At that time research in the use of locally available materials become important. This paper reviews work that has been conducted on the production and use of livestock manures and composts in soil fertility and productivity improvement in Uganda. Farmyard manure production and use, and related composts are emphasised.

Key words: livestock manures; composts; agricultural production

Introduction

Declining soil fertility has been a major problem in Uganda for many years since agricultural production for export was initiated. Improving and maintaining a high soil organic matter content can ameliorate this problem. Soil organic matter is the key to soil fertility and productivity. Organic matter plays a major role in the chemical, microbiological and physical aspects of soil fertility. Organic matter as a source of plant nutrients, primarily nitrogen, has received most attention and research (Olsen, 1986).

The simplest method of adding organic matter is by green manuring (Beckley, 1937; Simpson, 1986). However, in practice, green manuring often fails to simultaneously satisfy the two main functions of supplying available nutrients and building up soil organic matter, especially in the tropics (Simpsons, 1986). Earlier trials conducted at Serere, Bukalasa and other farms in the Northern and Eastern Regions (Department of Agriculture 1931 and 1932), it was concluded that green manures did not maintain the soil fertility and were not worthy the trouble involved. Recent work has however shown some agronomic response from the use of some green manures (Wortmann et al, 1994; Fischer, 1997).

The usual source of bulky organic manures is the dung and bedding of domestic animals. In Uganda, the partly decomposed accumulations of animal manures were usually used. In very few cases was this supply sufficient to meet the crop nutrient requirements on most farms. In an attempt to satisfy the needs, methods of composting other organic waste materials were developed to convert these materials into useful and readily available manures. Kraal and farmyard manures are the most common livestock manures. These manures composted with other materials like grasses can supply substantial amounts of nutrients. For the purpose of this paper, kraal manure is defined as the material obtained when cattle are provided with no bedding or roof, and normally consists of dung and urine mixed with soil. Farmyard manure is obtained when the cattle (sometimes under roof) are bedded down frequently with grass and the manure either made and stored under the animals or stacked outside the kraal to age. Composts include all manures manufactured from general farm wastes, with either urinated earth or artificial nitrogen starters and the final product is a fine, fairly dry, humic material with about the same carbon/nitrogen ratio as that of a fertile soil.

Beginning of research on manures in Uganda

The use of manures (both organic and inorganic) as sources of plant nutrients in Uganda came into light between 1903 and 1924 during the introductions of commercial cotton varieties. It is not clear why research on manures started at this point in time, but from Table 1, it is observed that seed cotton removed substantial amounts of nutrients particularly nitrogen compared to grains and banana fruit. The cotton seed cake was then used in coffee fields and in very few cases was it recycled in the cotton fields (Martin, 1940). Therefore, for sustainable production and export of cotton, it was imperative to device means of maintaining the fertility of the soils.

Previous to the introduction of commercial cotton, the native rotations of land and crops were quite sufficient to maintain the fertility of the land without use of any form of manures (Martin, 1940). The banana eating tribes took good care of their banana fields by keeping the stems clean, regularly removing the old leaves and chopping up the old

stems from which the banana fruits had been harvested. Peelings of the fruit and household refuse were scattered through the bananas. When the "tete" grass (*Cymbopogon afronardus*) that was used to cover the floors of the native huts was changed, the old material was thrown in the banana gardens. As a result of these operations, the bananas were mulched continuously and nothing was removed from the land except the actual fruit eaten. There is no evidence of other materials having been used to supplement the mulch from the banana trash and sometimes "tete" grass before 1903.

The grain-eating tribes did not grow bananas at that time. This is because the lands they occupied either did not produce good yields of bananas as the others or were of the short grass type that suited their animals and produced grains better than other crops. It is believed that at one time the grain eating tribes indirectly used kraal manure on their grain crops. However, this practice seems to have been abandoned when the European administration came into place. It is not clear why this was so, but these tribes attached a lot of importance to their animals and perhaps paid little attention to crops.

When commercial cotton was introduced, numerous trials where conducted with organic manures and artificial fertilisers. However, it was realised later that the importance of the results was the economic aspects of cash returns on the additional costs of the treatment. Under the Uganda conditions, the use of artificial fertilisers was hampered by their high cost associated with heavy freight charges due to geographical position. Secondly, cotton was grown entirely by the peasant farmer who was extremely unlikely to adopt any form of artificial fertilisation due to financial constraints. It therefore became evident that artificial fertilisers were likely to find market in Uganda only in cases where large benefit would be derived from their use, and where no similar benefit could be obtained from local substitutes. It is at this point in time that research on the use of locally available organic materials in the native agriculture started.

Production of manures before 1940

Recommendations from trials started to be passed on to farmers around 1940. Cattle were widely kept compared to other domestic animals and for this reason kraal and farmyard manures were considered the most important livestock manures. Before research started, no attempt had ever been made even in the best cattle districts to keep cattle in covered kraals and to produce and use the manure (Martin and Biggs, 1937). At the beginning of the research, little experimental work was conducted on kraal manure because of its being very wasteful of nitrogen.

Trials were conducted on farmyard manures from cattle housed in covered sheds and bedded down with elephant and *lusenke* (*Imperata cylindrica*) grasses. Different storing methods of the farmyard manures were investigated. Storing of the manure collected in roofed stacks gave the best results in terms of their fertilising qualities (Table 2). However, this technique was found to encourage the breeding of flies, which gave the cattle no rest and also had the possibility of carrying human disease. For this reason, this technique was not recommended. The recommended method for making farmyard manure was to store the manure under the cattle until required (Table 2). It was recommended that the cattle he kept in a covered shed, darkened as much as possible to reduce the hreeding of flies, and bedded down daily. It is reported that little labour was involved in this process before the final transportation to the field. This method was found to be suitable for use by the native farmer (Martin, 1940).

Compost-making experiments were conducted entirely on ordinary farm wastes and no leguminous crops were grown specifically for composting. It was very unlikely that the native farmers would adopt the technology with leguminous crops.

The Adco process, which was developed at Rothamsted, was tried in Uganda as early as 1925 (Stephens, 1937). In brief, the process consisted of composting straw and other similar wastes with a source of available nitrogen and some basic material. A modification was made to suit East Africa (Beckley, 1930). Uneven decomposition and sometimes cases of stacks firing were encountered with this process and this was attributed to the difficulty of wetting the stacks evenly (Beckley, 1937).

Experiments on compost making using the Indore process were initiated at Serere and Bukalasa Experimental Stations. The production process was modified to suit the peasants

Table 1. Nutrient removal by cotton, some grains and banana fruits at the indicated yields under average rain-fed conditions.

Crop	N	P_2O_5	K_2O	Yield
		kg/ha		Ton/ha
Seed cotton [a]	156	36	151	2.5
Maize (grain) [a]	100	40	29	6.3
Sorghum (grain) [a]	60	35	75	2.0
Millets (grain) [a]	60	40	70	3.0
Bananas (fruit) [b]	23	7	67	25.0

Source: [a] Halliday and Trenkel, 1992; [b] Sys et al., 1993

Table 2. Composition of farmyard manures produced and stored in different ways.

Storage Method	% Moisture	% N	C/N
Rotted in pit with roof [a]	40.8	1.05	11.3
Rotted in pit, no roof [a]	37.3	0.69	18.5
Rotted in stack, no roof [a]	47.7	1.24	12.9
Rotted in stack with roof [a]	39.3	2.15	13.9
Rotted in pit with soil cover [a]	60.4	1.29	18.3
Stored under cattle [b]	56.1	1.50	14.9
Stored one year under cattle [c]	65.1	1.17	15.3
Stored one year under cattle, then exposed in heap two months	63.0	0.56	19.1

Source: Stephens, 1937; [a] Elephant grass bedding; [b] Herd fed on concentrates, *Lusenke* grass bedding; [c] *Lusenke* grass bedding.

in Uganda using locally available materials. At Serere, composting trials with *lusenke* (*Imperata cylindrica*) were conducted (Stephen, 1937). This grass was abundant in most parts of the Eastern Region. It was considered useless for grazing and was therefore the material most readily available for composting. In Bukalasa, elephant grass was used. It was found that decomposition in pits was extremely slow, particularly during the rainy weather. Accordingly, the experiments were conducted in heaps above ground level. The composition of composts made in different ways is shown in Table 3.

Both the Adco and Indore processes, transport of the bulky vegetation materials and water to the site of composting were the two main obstacles in their economic production on farm (Storey, 1937). Large amounts of water were required and often the water supply was at a distance from the native homesteads. It was found much easier to drive cattle to the water holes, but the transport of water and the bulky vegetation materials was very difficult for the native farmer who had no wheeled transport. Under such conditions, it was preferable to advise the native farmers to manufacture and store manure in covered kraals under the animals (Stephens, 1937). This was less labour intensive and produced better quality manure (Tables 2 and 3).

In areas where cattle could not be kept owing to the presence of biting flies (*Glossina* and *Stomoxys*), trials of the Adco process of compost making were conducted. It was found that the labour involved in the frequent turning of the heaps, together with the initial cost of the starters such as ammonium sulphate and calcium carbonate, rendered this process less economic than a plain mulch for the native farmers (Stephens, 1937; Martin, 1940).

Use of manures before 1940

Observations from a number of trials conducted using the manures manufactured above showed that the manures improved the yields of coffee. The application of the manures was inclined to exaggerate the tendency to over-bearing of the coffee. However, this could be avoided by application of a light mulch as soon as the manure was dug in. It was found best to apply the manures after the crop had set. At this stage, it was presumed that the manures would stimulate the trees to carry their crop, ripen it, and produce the wood for the next crop. Kraal and farmyard manures were also used with success on tea gardens. The tea trees flushed well and regularly, and yields were good (Martin, 1940).

Kraal manure was applied at Serere on a continuous planting experiment with cotton. One set of plots was manured at the rate of 60 tons per acre each season. The manured plots always gave increased yields over the control plots. However, the yields of the control plots did not fall off to the expected levels. Later experiments at Serere and Ngetta with farmyard manures gave disappointing results with the application rates of 10, 20 and 30 tons per acre. It was presumed that these heavy application rates promoted vegetative growth at the expense of the fruit. New fertility experiments were proposed to include trials with 0, 2.5, and 5 tons of farmyard manure per acre (Martin and Biggs, 1937).

Although the benefits of application of farmyard manure to cotton was not yet well established by 1940, their effect on the native food crops in the short-grass areas had been observed. Both sorghum and finger millet responded quickly to the manure. The results indicated that the position of the manure in a rotation should be on the food crop rather than on cotton. In this cycle, the cotton would reap only the benefit of any residual effect of the manure, and would not be stimulated to heavy vegetative growth, as was the case when the manure was directly applied to cotton (Martin, 1940).

Production of manures after 1940

Little research work was conducted on the production of manures after 1940. This was due to the low prices of nitrogenous fertilisers after the Second World War and the establishment of the phosphate plant at Sukulu Hills, in Eastern Uganda. However, the collapse of the phosphate plant (Kauwenbergh, van 1991) coupled with escalated prices of imported fertilisers has led to an increase in the demand for organic manures as soil amendments. Due to the increasing scarcity of land to produce grasses for bedding kraals in addition to lack of labour, other methods of improving the nitrogen status of animal manures are being investigated.

In light of this, some chemical preservatives have been evaluated to minimise nitrogen loss in the manures. From preliminary results, single superphosphate has been identified as a promising chemical preservative (Table 4).

Use of manures after 1940

Table 3. Composition of composts made in different ways

Origin	% Moisture	%N	C/N
Serere Wet	9.1	0.43	13.9
Serere Dry	1.8	0.46	17.2
Serere 90 days	65.0	0.62	15.3
Serere 45 days	57.6	0.77	14.6
Serere S.H. 1	33.2	0.51	14.7
Serere S.H. 6	23.3	0.35	12.2
Mbarara	38.0	0.78	12.1
Bukalasa	57.0	0.77	17.7

Source: Stephens, 1937.

Table 4 Effect of chemical preservatives on nitrogen content in cattle dung and urine

Treatment	Dung %	Urine %
Control	0.59	2.0
Calcium sulphate	0.98	2.2
Calcium nitrate	0.44	1.8
Single superphosphate	1.01	2.8

Source: Wejuli, 1997b. Analysis on dung conducted after 6 weeks of decomposition with preservative added at 12.5 g/kg and urine after 2 weeks with preservative added at 1 g/100ml.

After more than 20 years of trials, it was concluded from the soil fertility experiment initiated in 1937 that a rate of 2.5 tons/acre of farmyard manure in 5 years with two years rest of land maintained or slightly increased soil fertility (Jameson and Kerkham, 1960; Mills, 1961).

A census of agriculture and livestock conducted in Uganda (MAAIF, 1993) shows that chicken is by far the most widely kept livestock (Table 5). However, it is reported that there is an increase zero grazing cattle keeping in Uganda (Wejuli, 1997b, NARO/FARMESA, 1996). For this reason, cattle manure is becoming more important in agricultural production (Table 6). In absence of animal manures, composts have become important.

Conclusion

Table 5. Livestock distribution per holdings in Uganda with an estimated total holdings of 1.7 million

Livestock type	Estimated holdings number of	Percent of total holdings
Cattle	341,000	20 1
Goat	749,000	44.1
Sheep	219,000	12 9
Pigs	256,000	15.1
Rabbits	33,000	1.9
Donkeys/Mules	5,000	0.3
Chicken	1,100,000	64.7
Ducks	172,000	10.1
Turkeys	36,000	2.1
Geese and other birds	30,000	1 8

Source: MAAIF, 1993

Table 6. Percentage of farmers using livestock manures and composts in four districts of Uganda (sample of 20 farmers interviewed from one selected village)

Type of manure	Mpigi	Jinja	Masaka	Hoima
Cattle	60	45	30	5
Goat	0	5	0	0
Pig	0	0	10	0
Rabbit	5	0	0	0
Chicken	10	0	5	5
Compost	20	10	50	50

Source: Wejuli, 1997a.

Mixed farming on smallholder farms is on the increase as arable land decreases per household due to increased population. Therefore, a sustainable nutrient management system is imperative if crop and livestock productivity is to be increased.

Use of organic manures is important in soil productivity and fertility. A high organic matter content can reduce on the amount of artificial fertilisers required in addition to conditioning the soil. Animal manures are important organic materials, however, losses of nitrogen lowers their fertilising qualities. Use of grasses requires a lot of labour and materials that are scarce today. To overcome this in modern agriculture, research on use of chemical preservatives should be intensified. In the presence of large quantities of cattle manure, bio-gas production can be encouraged. The by-product (slurry) from the production of bio-gas can be recycled as manure. On-farm compost production also requires further investigation. The research should focus on methods that can reduce on labour requirements and use of human urine should be evaluated in the absence of other nitrogenous starters.

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