Chapter 2

Livestock Management and Manure Quality

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There is great concern over soil fertility decline in arable lands of the East African Highlands. In Kenya, it is estimated that 64% of the population resides in the highlands, with maximum population densities of over 1000 people km^{-2}. Losses of nitrogen (N) and phosphorus (P) were estimated at 42 and 3 kg ha^{-1} yr^{-1} respectively in the period 1982 to 1984. This decline is, in part, related to increased cropping intensity on shrinking smallholder farms, as many households subsist on less than 1 ha, and to the limited use of inorganic fertilizer. A system to check this problem of soil fertility decline has been developed where the small farms are utilized in a way that provides inputs in an intensive and integrated manner.

Integration of livestock and crop cultivation in a complementary manner is described as a mixed or crop-livestock management system. One important advantage of integrated farming is the opportunity to convert by-products and waste from one activity into inputs for another. This form of horizontal integration has environmental as well as economic benefits. The livestock provides inputs such as manure and draft power for crop production with crop by-products being used as animal feed.

Many mixed farming systems in Sub-Saharan Africa rely upon organic matter recycling to maintain soil productivity. Yet continuous land cultivation has resulted in nutrient depletion, decline in soil organic matter and loss of physical structure thereby leading to reduced crop production (Murwira *et al.*, 1995). The cycling of biomass through animals into manure and urine that fertilize the soil is an important linkage between livestock and soil productivity in these systems. A move from extensive livestock management based on grazing to intensive stall feeding of livestock requires more feed of high quality from improved harvesting and storage techniques (de Leeuw, 1997). The effort that is put into these intensive systems may be wasted if the manure obtained from such systems is not adequately managed. A survey was conducted among smallholders in Kariti administrative location in Central Kenya. Emphasis was placed on establishing the popularity of various types of stall bedding as well as their influence on manure quality. A link between manure quality in terms of nutrient composition and physical composition, colour, smell and biological activity was investigated.

Table 1. Chemical characteristics of manures collected during the survey of 299 farms in Kariti, Central Kenya.

	C:N ratio	Carbon (%)		N	P	K	Ca	Mg
		Organic	Soluble	------------------(%)-----------------				
Minimum	5.3	6.5	0.12	0.33	0.06	0.43	0.00	0.05
Maximum	81.3	49.7	8.0	1.91	0.75	7	1.34	1.19
Mean	23.1	24.5	1.97	1.12	0.31	2.39	0.26	0.51
SD[1]	9.6	8.8	1.30	0.33	0.12	1.07	0.21	0.19

[1]SD = Standard Deviation

Cattle Management

Table 1 presents chemical characteristics useful in determining manure quality based upon a survey of 299 farms in Central Kenya. Note that considerable differences were observed between the highest and the lowest values of the quality parameters of these manures. These variations may be associated with the way the manures are handled.

manures. These variations may be associated with the way the manures are handled, processed and stored. While nutrient concentrations serve as indicators of manure quality, these measurements do not reflect the actual amount of nutrient that could be available within the farms because manures with lower nutrient concentration might be available in larger supply.

Animal Management Factors Affecting Manure Quality

A summary of animal management factors affecting manure quality is presented in Table 2. Animal housing and floor type influenced the P and Ca concentration significantly while drainage had an effect on the C/N ratio and N concentration. Bedding significantly influenced the C/N ratio and P concentration while roofing type affected all the quality parameters under consideration except the C/N ratio, N and Ca concentrations. Including feed concentrates within diets also affected the P concentration of resulting manures. From these results, we conclude that zero grazing units with concrete floors without bedding that contain livestock whose feeding regime includes food supplements will produce better manure than other systems. Furthermore, following recovery, manure that is periodically turned will better conserve its nitrogen.

Effect of Feed Concentrates on Manure Quality

A trial was conducted to establish the effect of feeding cattle a high protein feed supplement on the quality of the manure. There were significant differences between the feacal and urine nitrogen contents of the excreta in response to the different rates of concentrates fed to the animals. Animals fed on high levels of concentrates produce excreta with larger amounts of N.

Table 2. A summary of significant factors that affected manure quality parameters

Factors	Number of farms	Mean
Housing effects on P content		
Zero grazing	20	0.42% P
Improved boma	240	0.30% P
Traditional boma	19	0.24% P
Floor type effects on P content		
Soil	286	0.30% P
Concrete	12	0.41% P
Feed concentrates effects on P content		
+ Concentrate	193	0.31% P
- Concentrate	86	0.28% P
Bedding mineral effects on N content		
+ Bedding	114	420 mg kg^{-1}
- Bedding	27	804 mg kg^{-1}
Bedding effects on carbon-nitrogen ratio		
+ Bedding	198	23.9
- Bedding	83	21.1
Turning effects on mineral N content		

+ Turning	61	667 mg kg^{-1}
- Turning	80	362 mg kg^{-1}

The relationship between the daily N intake per kilogram mean live weight of the steers and the N excreted in feaces and urine are shown in Figure 1. The N intake ranged between 0.300 and 0.458 g kg^{-1} LW_{mean} day^{-1} while N excreted ranged between 0.075 and 0.209 g kg^{-1} LW_{mean} day^{-1} and between 0.033 and 0.055 g kg^{-1} LW_{mean} day^{-1} in feaces and urine, respectively. The total N excreted (urinary + feacal N) ranged between 36 and 58% of the total N intake. Between 21 and 31% of total N excreted was contained in urine while the rest was excreted in the feaces. A linear relationship was observed between the daily N intake (NI) and the daily N excreted in feaces and urine with the urine better correlated to N intake than the feacal N. Similar relationships have been reported by Kirchgessner and Kreuzer (1986) who also observed that as the crude protein increased in the diets so did the feacal N excreted.

The difference in urinary N output may be explained by N intake, ranging between 60-180 g day^{-1}. This means that the diet offered was just sufficient to provide energy and protein needs leaving only modest amounts excreted in urine. Indeed, Mason (1969) observed that high fibre diets such as clover-rye grass hay and oat straw resulted in significantly higher undigested dietary N in feaces than concentrate supplemented diets in sheep. High fibre diets encourage enhanced rumen microbial activities culminating in richer feacal N excretion contain more bacterial byproducts.

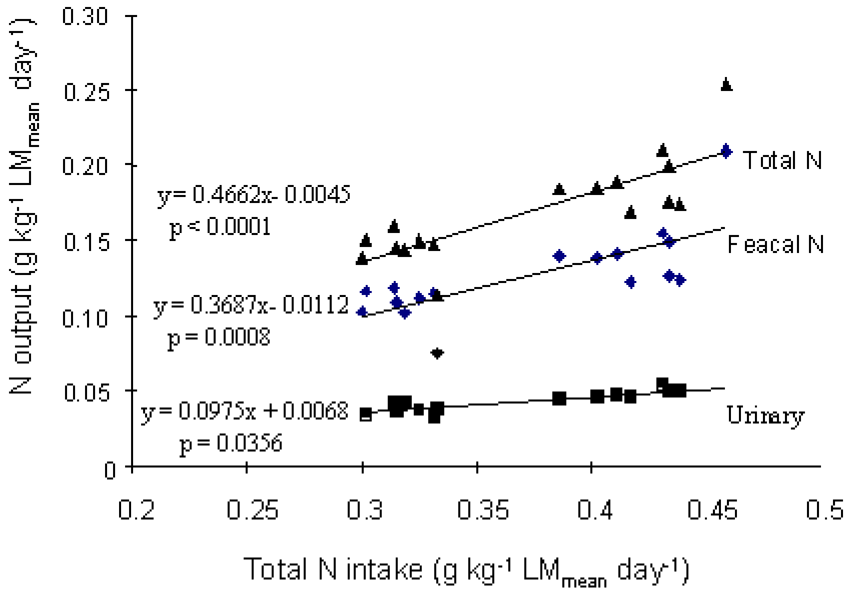

Figure 1. The relationship between nitrogen intake and N output (excreta) of steers raised in the Central Kenyan Highlands

Crop Residue Management

Crop residues are utilized for various purposes depending on the types available and the diversification of the farming system. When left lying in the field following crop harvest, straw, trash and stover enhance soil and water conservation and slowly recycle nutrients. Since most tropical soils are highly weathered, smallhold farmers in Kenya depend upon organic matter to recycle nutrients and sustain productivity (Sanchez, 1976; Murwira *et al.*, 1995). Crop residues are well suited for this purpose.

In an intensive crop-livestock farming system, crop residues are frequently used as livestock feed while the manure and urine produced are used to produce crops and fodder (Tanner *et al.*, 1995). The release of nutrients from manure applied to soil is more rapid than from crop residues, and exhibits a pattern that coincides more closely with crop nutrient demand. This nutrient release is highly dependent on the composition and microbial degradability of the farmyard manure (Dewes and Hűnsche, 1998).

Conclusion

The type of animal housing, storage strategies and the type of feed provided to farm animals each affect manure quality (Figure 2). For composted materials, the initial components that are combined determine the nutrient content and physical characteristics of the resulting product. It is expected that if one begins with higher quality materials, then the final compost will also be of higher quality if the appropriate composting, handling and storage procedures are followed.

Figure 2. This basic "zero-grazing" unit holding dairy cattle includes a roof, water storage tank and feeding trough. A mixture of manure, urine and bedding is regularly recovered and used as organic inputs to soil.

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