MINERAL CONTENT IN SOILS AND PASTURE GRASSES AT ASAS FARM, IRINGA, TANZANIA.

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SUMMARY

The assessment of mineral content in soil and pasture grasses was carried out in Iringa Tanzania to establish the existence of any particular mineral deficiency or excess on the farm. The following levels of soil minerals, sodium (Na): 2.28% and 3.30%; potassium (K): 0.47% and 0.36%; calcium (Ca): 2.26% and 5.2%; magnesium (Mg): 0.61% and 1.41%; manganese (Mn): 56.8 and 42.6 ppm; copper (Cu): 1.63 and 2.19 ppm and iron (Fe): 130 and 120 ppm were observed during the dry and wet season respectively. These were considered to be adequate sources for grazing animals. Soil zinc (Zn) was marginal in dry season (1.25 ppm) but was below critical levels (0.23 ppm) in wet season. In case of pasture grasses the following minerals were adequate in dry and wet season respectively, potassium (K) (0.67% and 1.89%); Na (0.13% and 0.35%); Ca (0.38% and 0.64%); Mn (93.7 and 87.8 ppm) and Fe (400 and 450 ppm). Whereas Cu (6.8 and 7.6 ppm), Zn (19.2 and 23.8 ppm) and Mg (0.15% and 0.17%) were below critical levels in dry and wet season respectively. Pasture phosphorous (P) was below critical levels (0.18%) in wet season but high in dry season (0.31%). The concentration of minerals in the soil did not correspond well with the mineral concentration in pastures. It was recommended to analyze the mineral concentrations in the animal tissues to ascertain the mineral status in the farm so as to establish a strategy for mineral supplementation.

INTRODUCTION

Forage provide an important source of minerals for grazing ruminants. In some instances, forages may provide adequate quantities of all essential minerals required by ruminants. However, in other situations, forages are deficient in one or more minerals. McDowell (1992), reported a summary of mineral inadequancy in tropical forages such as Ca, P, K, Na, Mg, Fe, Zn, Cu, Mn, Co and Se.

The concetration of mineral elements in plants are dependant on the interaction of a number factors including soil, plant species, stage of maturity, yield, pasture management and climate. McDowell (1985) and Reid and Horvath (1980) (as cited by McDowell, 1992) observed that the extend to which the factors affect the concentration of a mineral element in the plant tissues varies with the different mineral as well as the treatment (such as fertilization, pH regulation). This would also affect the mineral intake by livestock and humans as reported by Underwood (1981).

Season of the year affects mineral intake which in turn affect mineral consumption by animals. Cunha (1983) reported that, during winter or dry season forages stop growing, lose the green colour and become high in fibre and lignin hence reduce their digestibility and mineral availability. Similarly, McDowell (1985) reported that when plants mature their mineral content declines.

Based on this information mineral sources may fail to meet the animal requirements. In such a situation, failure to supplement the animal with other sources of minerals may lead to poor performance of animals indicated by low reproduction rates, reduced growth rates, reduced feed conversion efficiency, reduced production of milk, meat, increased susceptibility to disease infections and sometimes death, (Arthur and Boyne, 1985; Boyne and Arthur, 1986; Underwood, 1981).

It has been established that minerals such as copper, selenium, cobalt, phosphorus, potassium, zinc and sodium are marginal to deficient in some areas of Tanzania (Phiri, 1995; Sendalo *et al*, 1988; Maro *et al*, 1980; Mwakatundu, 1977; Rodgers, 1975 and Naik, 1965) and may contribute to poor livestock health and low production (Kasongo *et al*, 1997).

Identifying minerals that limit performance or health in grazing ruminants under field conditions in Tanzania remain a major problem and hence a need to establish its magnitude is a prerequisit for increased livestock production and improvement of health. The aim of this study was to establish the existence of the particular mineral deficiency or excess on the farm by determining the mineral composition of soils and pastures. The owner of the farm were this study was conducted had for some time been suspecting mineral imbalance problems (reduced growth, delayed conception, long calving intervals, abortions and poor milk production) which required investigation so as to improve production of his animals.

MATERIALS AND METHODS

Experimental Site

The project was conducted in Iringa region between June 1994 and February 1995 on a private farm called ASAS situated in a village of Nduli. The farm is located 10-12 km from Iringa town along the highway to Dodoma and it has an area of 632 acres which are used for grazing and pasture cultivation. The dominating pasture grass species included *Hyperrhenia spp, Heteropogon spp, Cynodon dactylion, Penicum maximum, Pennisetum puerperium, Brachiaria spp, Chloris spp.* In cultivated pasture plots, farmyard manure (FYM) and Triple super phosphate (TSP) fertilizer are used in variable amounts 15 - 50 kg/ha. The climate of the area was characterized with two seasons, a dry season (June - mid November) and rain season (mid November to May). The rainfall was 90mm and 30mm in December 1994 and January 1995 respectively. The farm had a total of 380 cattle and 180 sheep and goats at the start of the study. These animals were grazed throughout the day (9.00 am to 5.00 pm) with concentrate given to the milking herd only. Grass hay is supplemented to all animals during the dry season only.

Soil Sampling and Analysis

Samples were collected from 0 - 20 cm of top soil, in 12 randomly selected points covering both unfertilized and fertilized plots. To avoid contamination of samples site close to the roads were avoided and clean, rust free tools were used. Soil samples were air dried at 35^{0}C and passed through a 2mm sieve. Soil pH (in water) was determined by using glass electrodes as described by Maclean (1965). Soil particle size were determined by using hydrometer method as described by Okalebo *et al* (1993). Total available nitrogen percentage was carried out using the wet-acid oxidation based on micro-Kjeldahl oxidation method (Bremmer and Mylvaney, 1982). Percentage organic carbon (OC) was determined by the wet combustion method (Nelson and Sommers 1982).

The amounts of exchangeable Na and K were determined by flame photometry, while Ca and Mg by atomic absorption spectrophotometry in 1M NH_4OAC (ammonium acetate), as described by Dewis and Freitas (1970). Available P was determined according to methods described by Bray and Kurtz (1945). Trace elements Zn, Cu, Fe and Mn were determined by DTPA extracting method as described by Lindsay and Narvell (1978).

Grass Pasture Sampling and Analysis

With each soil sample a subsequent grass sample was taken. Only upper part 5 cm from the ground were sampled washed with distilled water, dried at 65°C to constant weight and dry matter determinined. The dry samples were ground, ashed and acid digested for mineral analyses. Phosphorus, Na, K, Ca, Mg, Fe, Mn, Zn and Cu levels were determined using atomic absorption spectrophotometry (Milner and Whiteside, 1984). Crude protein (CP), Crude fibre (CF) and P were determined by methods recommended by AOAC (1972) as described by Helrich (1990).

RESULTS AND DISCUSSION

Soil analyses

Overall means and ranges of analyzed soil parameter (pH, texture, total N%, and OC%) are given in Table 1.

The minerals analyzed i.e. Na, K, Mg, Ca, P, Cu, Zn, Fe and Mn are shown in Table 2.

Soil Na, P, Mg, Fe, Mn and Cu were adequate for pasture crops (based on the minimal levels given by Okalebo et al. (1993) and Landon (1991). The results on K, Na, Mg and Fe were similar to those reported by Sendalo (1987) and Mwakatundu (1977). Sendalo (1987) reported adequate amounts of these elements in Morogoro whereas Mwakatundu (1977) reported adequate amount in Tanga, Mbeya and Arusha, Tanzania. This probably could be a reflection in most volcanic and mountains areas of Tanzania. Calcium level was close to minimal levels in June 1994 but high in February 1995. The level of Zn was close to the minimal level in June 1994 but lower in February 1995. Plots where FYM or TSP had been applied had the highest P, Ca, Na and Mn.

Table 1. Soil characteristics at ASAS farm, Iringa, Tanzania.

	Mean minimal level	Mean (n =12)		Minimum		Maximum	
		DS	WS	DS	WS	DS	WS
pH (in water)		6.5	6.3	6.0	5.8	7.1	6.6
% Total N	< 0.05a	0.07	0.11	0.04	0.05	0.17	0.18
% OC	< 0.50a	0.99	1.06	0.10	0.25	6.16	2.74
% Sand		66	55	19	31	87	81
% Course silt		8.8	8.0	2	4	16	12
% Fine silt		6.8	9.7	2	2	22	20
% Clay		19	27	9	11	43	43
Soil class		SL	SCL				

DS = Dry Season (June 1994), WS = Rain Season (February 1995)
SL = Sandy Loam, SCL = Sand Clay Loam
a = Okalebo et al. (1993)

The concentration of all minerals in crop and forage plants depends on soil mineral level, soil pH, plant species, climatic or seasonal conditions during growth, stage of forage maturity and application of fertilizers or waste materials (McDowell, 1992). The extent to which these factors actually affect the concentration of a mineral element in the plant tissue varies with different minerals and with the treatments imposed by man in his efforts to increase crop or pasture yields (McDowell, 1996).

Pasture K, Na, Ca, Mn and Fe (Table 3) were adequate in the forage based on minimal levels given by Landon (1991) and McDowell (1983).

The high contents of K, Na, Fe, Mn observed in these studies may be related to the high levels of the elements in the soil. Underwood (1981) observed that soils with adequate amounts of Ca tend to produce forage with high content of the elements. In June 1994 Ca was marginal to minimal levels but in February 1995 Ca content was high and corresponded well with the high

Table 2: Mineral concentrations in soil at ASAS farm, Iringa, Tanzania.

	Mean minimal level	Mean (n =12)		Minimum		Maximum	
		DS	WS	DS	WS	DS	WS
Exchange bases (%)							
Na		2.28	3.33	1.01	1.17	5.60	6.60
K	< 0.13a	0.47	0.36	0.17	0.05	0.88	0.63
Ca	< 2.50a	2.55	5.20	0.26	0.76	13.9	12.2
Mg	< 0.17a	0.61	1.41	0.06	0.18	1.58	2.23
Available P (ppm)	< 15a	33.2	18.8	3.1	1.5	85.1	55.9
Micro-nutrients (ppm)							
Cu	< 0.20b	1.63	2.19	0.20	0.40	4.60	5.10
Zn	< 1.00b	1.25	0.23	0.80	0.11	2.20	0.30
Fe	< 4.50b	130	120	39	30	800	520
Mn	< 25b	56.8	42.7	18	2	126	80

DS = Dry Season (June 1994), WS = Rain Season (February 1995)
SL = Sand loam, SCL = Sand Clay Loam, a = Okalebo et al. (1993); b = Landon (1991).

content in the soil. Copper, Zn, Mg and P content in pastures were below minimal levels. Phosphorus, Cu and marginal Zn deficiencies in pasture have also been reported by Sendalo et al (1987), Maro *et al.* (1980), Mwakatundu (1977) and Rodgers (1975).

CONCLUSIONS

Soil and pasture analysis indicated low Zn, Cu, P and Mg on the farm, hence animal depending solely on pasture are likely to suffer deficiencies of these minerals. It is possible that deficiencies of these minerals might contribute to the observed

Table 3: Mineral concentrations in pastures at ASAS farm, Iringa, Tanzania.

	Mean minimal level	Mean (n =12)		Minimum		Maximum	
		DS	WS	DS	WS	DS	WS
Macro-elements (%)							
Na	< 0.06a	0.13	0.35	0.11	0.24	0.18	0.40
K	< 0.60a	0.67	1.89	0.10	1.39	2.55	2.74
Ca	< 0.30a	0.38	0.64	0.28	0.54	0.55	0.70
Mg	< 0.20a	0.15	0.17	0.09	0.11	0.29	0.41
P	< 0.25a	0.18	0.31	0.10	0.22	0.55	0.40
Micro-elements (ppm)							
Cu	< 8a	6.8	7.6	2.0	4.0	16.0	11.0
Zn	< 40a	19.2	23.8	12.0	17.0	28.0	30.0
Fe	< 50a	400	450	80	100	600	800
Mn	< 25b	93.7	87.8	80	36	220	126

DS = Dry Season (June 1994), WS = Rain Season (February 1995), a = McDowell et al. (1983); b = Landon (1991)

reduced growth rates, delayed conception, abortions and poor milk production in animals at this farm. Further research is needed to analyze the level of minerals in the animal tissues to come up with better advice(s) to the farmer.

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