STUDIES ON SOIL-PLANT-ANIMAL RELATIONSHIP IN RESPECT OF MICRONUTRIENTS OF MIDNAPORE DISTRICT, WEST BENGAL

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BY

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C E R T I F I C A T E

This is to certify that the work recorded in the thesis entitled " STUDIES ON SOIL-PLANT-ANIMAL RELATIONSHIP IN RESPECT OF MICRONUTRIENTS OF MIDNAPORE DISTRICT, WEST BENGAL ", submitted by Dr. Kartic Chandra Das in partial fulfilment of the require - ments for the Degree of Master of Veterinary Science in Veterinary Medicine of the Bidhan Chandra Krishi Viswavidyalaya, is the faithful and bonafide research work carried out under my personal supervision and guidance. The results of the investigation reported in the thesis have not so far been submitted for any other Degree or Diploma. The assistance and help received during the course of investigation have been duly acknowledged.

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APPROVAL OF EXAMINERS FOR THE AWARD OF THE
DEGREE OF MASTER OF VETERINARY SCIENCE

We, the undersigned, having been satisfied with the performance, of Dr. Kartic Chandra Das, in the Viva Voce Examination, conducted to-day the 19th August 1991, recommended that the thesis be accepted for the award of the Degree.

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C O N T E N T S

LIST OF TABLES

LIST OF ABBREVIATION USED IN THE TEXT

Following abbreviations have been adopted for the purpose of convenience in the present text

B	=	Basophil
BGL	=	Blood glucose level
Co	=	Cobalt
Cu	=	Copper
DLC	=	Differential leucocytic count
E	=	Eosinophil
Fe	=	Iron
g	=	gram
Hb	=	Haemoglobin
Kg	=	Kilogram
L	=	Lymphocyte
M	=	Monocyte
mg	=	milligram
ml	=	millilitre
mm	=	millimetre
Mn	=	Manganese
Mo	=	Molybdenum
µg	=	Microgram
N	=	Neutrophil
PCV	=	Packed cell volume
ppm	=	Parts per million
SI	=	Serum iron

SCu	=	Serum copper
SCo	=	Serum cobalt
SMn	=	Serum manganese
SMo	=	Serum molybdenum
SZn	=	Serum zinc
TEC	=	Total erythrocytic count
TLC	=	Total leucocytic count
TSP	=	Total serum protein
Zn	=	Zinc

CHAPTER I

INTRODUCTION

Nutrition deals with the needs of the organism for sustenance. Its inadequacies can occur in almost all the areas of the globe and result in inefficient animal production. Numerous mineral deficiencies, imbalance and toxcities in soils and forages inhibit the grazing livestock industry (Fick et al. 1979 ; Miles and McDowell, 1983 ; McDowell, 1985). Grazing livestock in tropics, due to lack of mineral supplementation, depend largely upon forages to supply their mineral requirement. However, rarely can forages completely satisfy each of the mineral requirements for grazing animals. Concentrations of mineral elements in forages are dependent upon the interaction of a number of factors, including soil, plant, stages of its maturity, yield, pasture management and climate. Most naturally occuring mineral deficiences in herbivores are associated with specific regions and are directly related to soil characters. In tropical regions under conditions of heavy rainfall and high temperature, there is a marked leaching and weathering of soils, making them deficient in plant minerals. As the soil pH increases, the availability and uptake of Fe, Mn, Zn, Cu and Co decrease whereas Mo and Se concentrations increase.

It is widely accepted that tropical forages are less digestible than temperate species and therefore, daily consumption by grazing ruminants are lowered (McDowell et al. 1986).

Wasting diseases, loss of hairs, depigmented hairs, skin-disorders, non infectious abortion, diarrhoea, anaemia, loss of

appetite, bone abnormalities, tetany, low fertility and pica are the clinical signs, often suggestive of mineral deficiencies throughout the world. From tropical alluvial plane of Nadia district, West Bengal, Sarkar et al. (1990) observed clinical signs consisting of stunted growth and poor productivity in grazing goats, reared on micromineral deficient pastures.

Research on tropical regions has shown that mineral supplementation increases calving percentage by 20 to nearly 100% ; growth rates from 10 to 25% and reduce mortality significantly (McDowell and Conrad, 1977). The cost of mineral supplementation is the least for improvement of livestock production. Nevertheless, mineral supplements should be used only when the mineral requirements of animals can not be met with the available feeds alone, and only as local conditions dictate. The provision of extra minerals beyond these needs is economically wasteful.

Therefore, studies on soil-plant-animal relationship in respect of minerals are important because of their implications on animal production. A little information in this respect is available in India. Even there is no systematic mapping in relation to mineral deficiencies or excess for grazing livestock in India.

In view of the above facts, the purpose of this research work is to evaluate the followings -

1. Micro-minerals status in soils.
2. Micro-minerals status in plants.
3. Micro-minerals status in animals (cattle) with different types of abnormalities.
4. Suitable therapeutic measures.

CHAPTER II

REVIEW OF LITERATURE

2.1 Trace minerals status of soil in grazing field

2.1.1 pH of the soil in grazing field

Halder (1977) observed that the pH of the soil of different parts of West Bengal ranged from 5.3 to 8.3. He also noted that the pH of the soil of Nadia district varied from 6.4 to 7.9. In his further report, pH of the soil of the district of Murshidabad, 24-Parganas, Burdwan, Hooghly and Howrah varied from 6.7 to 8.3, 6.4 to 7.8, 5.3 to 7.7, 5.7 to 7.4 and 6.4 to 7.5 respectively.

2.1.2 Status of iron in soil

Mitra (1975) reported that soils of different rice growing tracts of West Bengal contain water-soluble plus exchangable ferrous iron, practically nil.

Sousa et al. (1981) observed in 5 experimental farms of Northern Mato Grosso, Brazil that the soil extractable iron was slightly low for the production of crops in 2 of the farms but adequate iron (20 µg/gm) in the rest.

Halder, M. and Mandal, L.N. (1981) reported that application of Cu decreased the content of extractable Zn, Fe, Mn and P in the soils. Application of Mn also depressed the content of extractable Cu, P but increased that of extractable Zn.

Saha et al. (1982) reported mean value of available iron content in the soils of West Bengal - 75.7 ppm.

The scheme on Micronutrients sponsored by I.C.A.R. (1983-84) in the soils of West Bengal pointed out that the average content of DTPA extractable iron in the soils of Nadia and Hooghly district were 62.6 and 94.1 ppm respectively. Whereas in Coochbehar and Jalpaiguri districts are 72.6 and 117.2 ppm respectively.

Pal et al. (1985) observed that the distribution of Fe in the soils of low lying rice fields of four acidic tracts districts of West Bengal varied between 13.3 to 116.2 ppm.

Brun et al. (1987) reported Fe content of 3 experimental soils Paiaguas-region of Pantanal Mato, Grosso, Brazil ranged from 88.9 to 174.9 mg/kg.

Sarkar (1989) estimated Fe content of soils of Nadia district ranging from 17.80 $\pm$ 0.78 ppm to 328.30 $\pm$ 0.91 ppm.

2.1.3 Status of copper in soil

Randhawa and Kanwar (1964) observed that the total content of Cu in the soils of Punjab varied from 6.6 to 36.4 ppm.

Kanwar (1978) reported the normal available range of Cu in the soil of India varied from 1-40 ppm (average 9 ppm).

Halder and Mandal (1979) estimated the copper content of soils of some parts of West Bengal and found that it ranged from 18.75 to 52.78 ppm with mean value of 32.7 ppm.

Lopes et al. (1980) reported that the soil from 3 ranches selected at random from each of 5 municipalities of Mato Grosso

area of Goios State (Brazil) having Cu < 1 µg/gm.

Saha et al. (1982) observed that the mean value of available copper content in the soils of West Bengal was 7.62 ppm.

Report (1983-84) on the scheme on Micronutrients of the soils of West Bengal showed that the mean content of DTPA extractable copper of Nadia and Hooghly districts were 6.5 and 5.4 ppm respectively, whereas that in the soils of Coochbehar and Jalpaiguri districts were 8.7 and 9.0 ppm respectively.

Pal et al. (1985) estimated the copper content in the soils of low land rice fields of four of acid tract districts of West Bengal and the value ranged from 3.00 ppm to 77.00 ppm.

Brun et al. (1987) observed that Cu content of 3 experimental soils of Paiaguas-region, Mato, Gresso, Brazil, ranged from 0.3 to 0.7 mg/kg.

Sarkar (1989) estimated the Cu content in the soils of Nadia district and found that the value ranged from 1.83 to 5.80 ppm.

2.1.4 Status of molybdenum in soil

Dakshinamurti et al. (1955) reported that the Mo content in the soils of Delhi ranged from 0.7 to 2.6 ppm.

Chatterjee and Dakshinamurti (1962) found Mo content of alluvial soils of India ranged from 1.0 to 5.60 ppm.

Randhawa et al. (1961) reported the Mn content in the soils of the Punjab varied from 288 to 922 ppm.

Biswas and Gawande (1964) observed the total Mn content in Indian soil varied from 92 to 1150 ppm.

Sousa et al. (1981) observed in six experimental farms of Northern Mato Grosso, Brazil that Mn concentration in soils were slightly low, 6 and 14 µg/gm in 2 of the farms but adequate i.e. 20 µg/gm in the other four farms.

Brun et al. (1987) estimated Mn in three experimental soils in the Paiaguas-region, Mato, Grosso, Brazil, varying from 17.0 to 26.0 mg/kg.

2.1.7 Status of zinc in soil

Rao (1937) observed that the Zn content of soil in Andhra Pradesh varied from 300 to 600 ppm.

Swaine (1955) reviewed the average value for most of the mineral soils which varied between 10 and 200 ppm.

Chatterjee and Das (1964) estimated the Zn content of some Indian soils and mean value ranged from 21.5 to 88.7 ppm.

Lopes et al. (1980) reported that the soil from 3 ranches selected at random from each of 5 municipalities of Mato Grosso area of Goias State (Brazil) contained Zn having the value less than 1 µg/gm.

Halder and Mandal (1981) reported that the application

of Cu decreased the content of extractable Zn, Fe, Mn and P in soils ; the rate of decrease gradually declining with progress of incubation period. Application of Mn also depressed the content of extractable Cu, Fe, P but increased that of extractable Zn in soil.

Brun et al. (1987) estimated Zn content of soils in Paraguas-region, Mato, Grosso, Brazil which varied from 0.7 to 1.6 mg/kg.

Sarkar (1989) reported that Zn content in soil of Nadia district was found to vary within the range of 2.31 ppm to 13.08 ppm.

2.2 Trace minerals status of plants in grazing field

2.2.1 Status of iron content in plants

Brown (1955) estimated the Fe content in corn and rice and found that the value was 178 and 80 ppm respectively.

Wallace and Lunt (1960) reported that the Fe content of soyabean varied in the range of 40 to 60 ppm.

Kanwar and Chopra (1963) observed that Fe content of citrus plant was 144 ppm.

Arora and Smith (1969) reported that Fe content of soyabean plant was 524 ppm.

Milap Chand (1969) estimated the Fe content in grains and straw of wheat, var-kalyansona and found that the value var-

fed from 50.3 to 50.7 ppm and 94.8 to 116.5 ppm respectively.

Chimania (1969) observed that Fe content in grain and paddy straw was in the range from 26.6 to 35.4 ppm and 429 to 722 ppm respectively.

McDowell and Conrad (1977) stated that natural feed stuff contained enough Fe to meet the requirements of farm livestock.

Sawhney et al. (1977) reported that the values of Fe contents in µg/g of dry matter ranged from 93.12 to 488.35 in cereal straws ; in grasses 144.23 to 502.97 and 299.11 to 514.29 in legume fodders.

N.R.C. (1978) made dietary recommendation of 50 ppm of Fe to prevent iron deficiency in ruminants.

Aiyer (1984) reported that iron content of rice straw was 20.44 ppm.

Boila et al. (1985) observed that the Fe content of 612 grass samples varied from 31.3 to 1044.5 mg/kg and Fe content of 271 legume samples varied from 29.8 to 617.2 mg/kg respectively in the cattle producing area of north-western Manitoba. Mean Fe content for the entire study area was 107.6 mg/kg for grass and 93.6 mg/kg for legume samples.

Brun et al. (1987) estimated the Fe content of 5 pasture species of the Paraguas region, Mato, Grosso, Brazil and found that the value ranged from 73.0 to 472.8 mg/kg.

Murugan et al. (1987) observed that the available Fe content in certain plants of Tamil Nadu such as Ficus religiosa, Azardirachta indica, Enterolasium saman, Albizia lebbeck and Millingtonia hortensis are 220.61 ± 0.90, 239.59 ± 1.52, 201.75 ± 4.99, 126.66 ± 3.30 and 140.94 ± 2.81 respectively.

Sarkar (1989) reported that Fe content in plants of the grazing field of Nadia district varied from 360.44 ± 0.81 to 3142.16 ± 5.18 ppm.

Talpada et al. (1989) estimated the Fe content of P. juliflora pods in summer and monsoon seasons and found that the value was 203.50 and 638.80 ppm respectively.

2.2.2 Status of copper content in plants

Subba Rao (1953) estimated the optimum requirement of Cu for barley, rice, maize and sugarcane and observed that these crops required 1.9, 6.25, 26.0 and 2.11 ppm of Cu respectively.

Pattanaik (1955) observed that the optimum requirement of Cu for rice was 0.001 ppm as determined by water cultures.

Agarwala and Sharma (1961) reported that the Cu concentration in the barley, legumes, cereals, paddystraw and wheat grains were 0.55, 9.5 to 17.5, 12.5 to 29.6, 3.1 to 20.8 and 2.3 to 3.1 ppm respectively.

Fisher et al. (1976) observed that the Cu content of hay from pasture is 5.3 mg/kg.

Sawhney et al. (1977) reported that wheat-bhusa and

Saba and Baikowski (1987) reported that fodder of Poland contained Cu 0.5 to 10.9 mg/kg D.M. (Dry matter).

Sarkar (1989) estimated the Cu content in grazing plants and found that the value varied from 23.5 to 125.61 ppm.

Talpada (1989) estimated Cu content of Prosopies juliflora tree in summer and monsoon seasons and found that the value was 12.46 and 15.52 ppm respectively.

2.2.3 Status of molybdenum content in plants

Agarwala et al. (1964b) observed that the Mo content of rice straw varied from 1.00 to 11.46 ppm.

Reddy (1964) observed the Mo content of grasses (24spps) in the range of 0.24 to 0.91 ppm.

Mehta et al. (1969) reported the Mo content of ricestraw ('N, 2-6') 0.34 and 1.00 ppm respectively.

Fisher et al. (1976) observed the Mo content of the hay from pasture 3.6 mg/kg only.

Froslie et al. (1983) observed in the area of Karatina, Kenya that 31 samples of pasture grass had Mo 1.4 ± 2.6 mg/kg (dry matter).

Sharma et al. (1986) reported the pasture grass from different agro-climatic zones of Himachal Pradesh contained Mo 0.08 to 0.64 mg/kg (D.M.).

Brun et al. (1987) estimated Mn content of 5 pasture samples and found that the values varied from 272.7 to 477.5 mg/kg in the Paiaguas-region, Mato Grosso, Brazil.

Talpada et al. (1989) estimated Mn content of Prosopies juliflora tree in summer and monsoon seasons and found that the values were 22.30 and 22.11 ppm respectively.

2.2.6 Status of zinc content in plants

Nair and Mehta (1959b) estimated the average Zn content of grasses except alfalfa and value was 18.5 ppm.

Bhumbala et al. (1965) reported that Zn content of wheat grain varied from 5.8 to 6.5 ppm.

Lopes et al. (1980) observed that dry forage had Zn / 10 µg/g in 9-25% of the samples in Mato Grosso area of Goias State of Brazil.

Froslie et al. (1983) reported that in the area of Karatina, Kenya, 31 samples of pasture grass had Zn 33 ± 10 mg D.M.

Boila et al. (1985) reported that the Zn content of 612 grass samples varied from 18.6 to 22.0 mg/kg and of 271 legume samples 17.8 to 22.5 mg/kg in the cattle producing area of north-western Manitoba.

Brun et al. (1987) estimated Zn content of 5 pasture species and the value varied from 5.6 to 7.1 mg/kg in the Paiaguas-region, Mato Grosso, Brazil.

Wang et al. (1987) reported the mean contents of Zn 13.5 mg/kg in grasses of Inner Mongolia.

Talpada et al. (1989) estimated Zn content of pods of Prosopies juliflora tree in summer and monsoon seasons and the value was 16.29 and 28.81 ppm respectively.

2.3 Prevalence

Sawhney and Bedi (1974) conducted a survey about the haemoglobin content of blood of 326 representative animals of various species, breed, age and sex belonging to various Government and private livestock farms in the hilly areas of Jammu and Kashmir and recorded more than 50% of the animals with low haemoglobin. In goat, Hb content was 6.0 ± 0.5 to 7.83 ± 0.3 g%.

Chillar et al. (1979) surveyed various livestock farms in the Tarai area of the districts of Nainital, Pilibhit and Lakhimpur in Uttar-Pradesh for examining haemoglobin content in blood of 260 cattle and buffaloes of various ages and observed that about 60% of livestock had low haemoglobin content in the area.

Kovacevic et al. (1982) observed that a sample of concentrate feeds given to a total of 789 cows, had an average copper content of 5.08 mg/kg in Yugoslavia. A control group of cows were given feed mixture with copper 24.14 mg/kg. The average content of copper in one was 41.9f mg for control cows and 137.87 mg for the test cows. Compared with control cows, the test cows had a significantly shorter service period and

required fewer insemination.

Phillipo et al. (1987) conducted two experiments to examine the effects of supplementation of control diet of barley grain and barley straw containing 4 mg Cu/kg DM either with 5 mg Fe/kg DM or with 500 or 800 mg Fe/kg DM on puberty, fertility and oestrus cycles of cattle. It was reported that Mo supplementation delayed the onset of puberty, decreased the conception rate and caused anovulation and anoestrus in cattle without accompanying changes in Cu status or in liveweight gain.

It was suggested that these effects of Mo are associated with a decreased release of LH that might be due to an altered ovarian steroid secretion.

Mongo (1988) reported that Co deficient animals showed significant decrease in body weight corresponding to the deficiency of Vit-B_{12}. The oestrous cycle was prolonged and progesterone level were altered and corticosteroid levels were high which was thought to be due to stress factor.

White et al. (1988) stated that Zn deficiency (3 mg/kg) produces ceasation of wool growth on the scrotum, reduced appetite, frothy saliva, skin lesions on the chin.

Wilson and Holmes (1988) reported that Co supplementation increased the average daily growth rate of cattle from 0.24 to 0.36 kg.

Kellogg et al. (1989) reported that the supplementation of Zinc methionine (zinc 360 and methionine 720 mg daily)

during lactation, increased milk yield without effecting fat or protein content of milk.

Kelkar et al. (1990) reported vaginal prolapse developed in 25 buffaloes at 7-10 months of gestation in Zn and Cu deficiency.

Zamarin et al. (1990) observed that a seasonal rise in ketone bodies in body fluids and hypo-glycaemia during the grazing season was over-come partly by a supplementation of potassium iodide and cobalt chloride.

2.4 Haematological changes in cattle

Filmer (1933) reported the absence of macrocytosis and reticulocytic response in cobalt deficient anaemia in cattle. In such cases erythrocyte count dropped to as low as 2.8 million/Cmm of blood, but in none of these cases or basophilic polychromasia, stipplings were observed.

Hahn and Whipple (1939) stressed the importance of adequate supply of dietary protein for optimum erythrogenesis since a low protein intake lowered the optimal production of haemoglobin, resulting in anaemia.

Udall (1954) observed that anaemia due to increased blood destruction was mostly associated with faulty nutrition, chronic infectious diseases, ascariasis, strongyliosis, stomach-worm disease, parasitism in general, piroplasmosis and parturient haemoglobinuria. He further reported that haemoly-

ytic agent may be a bacterial toxin as in ascariasis. The haematological changes included decrease in total erythrocytic count upto 50-75% with a marked decrease in haemoglobin.

Settlemire et al. (1964) while studing the physiological compensatory mechanism of a new-born calves suffering from iron deficiency anaemia, observed that they were able to compensate physiologically for their reduced oxyhaemoglobin content (oxyhaemoglobin less than 9%) by significant increase in respiration rate.

Mapes and Coop (1970) experimentally produced haemonchosis (Haemonchus contortus) in lambs and observed anaemia and fall in haematocrit value.

Smith et al. (1972) stated chronic haemorrhagic anaemia of ruminants to be hypochromic and slightly microcytic or normochromic in which potkilocytosis was a prominent feature. They further reported that Neoascaris vitulorum infection in cattle was responsible for causing haemorrhage when the larvae crawled out of the pulmonary capillaries to enter the alveoli.

Thakur and Misra (1973) worked out haematological studies on 493 calves with helminthic infections and observed that there was a decrease in percentage of haemoglobin, packed cell volume and total Red Blood Corpuscles (RBC) count. The results also showed an increase in the percentage of monocytes and eosinophils with slight decrease in the neutrophil counts in affected claves.

Schalm et al. (1975) observed that microcytic hypochromic anaemia was specific to iron deficiency or failure to utilize iron. They suggested that in such cases chronic blood loss or iron, copper deficiency must be considered as the cause. They observed that parasitism in cattle particularly Trychostrongyliosis produced a severe normocytic normochromic anaemia with haematocrit values as low as 127 without any evidence of reticulocytosis to compensate anaemia.

Blood et al. (1983) observed that clinical signs of anaemia do not appear until the haemoglobin level falls below 50% of normal. There has been depression of erythrocyte count and haematocrit values. In haemorrhagic and haemolytic anaemia increase in immature red cells in blood has been observed. Discolored plasma was observed in haemolytic anaemia. In iron deficiency anaemia, these has been hypochromasia caused by reduction in MCHC, low Hb level with normal erythrocytic count.

Pandey and Misra (1985) observed low PCV, Hb and TEC in calves suffering from Ascariasis, varying from 20-24%, 6.8 to 7.4 g/dl and 4.01 to 4.52 millions/Cmm of blood respectively.

Pandey and Misra (1987) reported marked decrease in PCV, Hb, TEC and leucocytosis with neutrophilia in buffalo cows suffering from anaemia secondary to nutritional haemoglobinuria. The anaemia was macrocytic hypochromic. There was also increase in the osmotic fragility of erythrocytes.

Sarkar (1989) reported that 61.48% grazing goats in Nadia district of West Bengal had low Hb content.

2.5 Biochemical changes in cattle

2.5.1 Status of blood glucose

Prasad et al. (1977) conducted experimental study on seven crossbred calves by feeding exclusively on a fern "Diplazium esculentum" for several days. There was a progressive anaemia with decrease in blood glucose value (44 mg% of blood) after feeding of fern.

Pandey and Misra (1985) reported normal blood glucose level in calves suffering from ascariasis.

Pandey and Misra (1987) recorded increased blood glucose level in buffalo calves in anaemia due to nutritional haemoglobinuria.

2.5.2 Total serum protein

Brenner (1966) reported a linear relationship between serum protein and Hb concentration in calves suffering from chronic anaemia. Anaemia in these calves was produced by infecting orally with one of the three gastrointestinal nematodes mentioned below, or by bleeding 200 to 500 ml of blood daily for 8 to 14 weeks. It was noticed that for a given fall in Hb concentration the relative severity of reduction in serum protein concentration was in decreasing order

- Oesophagostomum radiatum ; Bunostomum phlebotomum ; Haemonchus placei and Jugular phlebotomy.

Suteu and Giurgea (1971) reported hypoproteinaemia in 36% of acute cases of cattle suffering from babesiosis. A fall in albumin was noted 71% in cases with an increase in globulin value.

Buonacorsi et al. (1972) worked out different haematological tests on ten calves with the symptoms of anaemia. The animals were exclusively fed on milk substitutes. Out of ten calves three were observed to be suffering from ferroprotein deficiency anaemia and the rest with either iron deficiency or haemolytic anaemia.

Singh et al. (1973) observed no changes in total serum protein in twenty cases of bovine haematuria but reduction in serum albumin and increase in serum globulin, resulting in decreased albumin globulin (A/G) ratio, which was recorded in all the twenty cases studied.

Schalm et al. (1975) observed that low dietary protein intake leads to nutritional deficiency anaemia.

Gardner et al. (1976) reported mean values and seasonal variation in total plasma protein of a dairy herd with post-parturient haemoglobinuria similar to those recorded over the same period in a healthy control herd.

Borah et al. (1983) reported no significant change in total serum protein in twenty cases of goat infected with

Strongyloides papillosus, but reduction in serum albumin and increase in serum globulin, resulting in decreased albumin globulin (A/G) ratio.

Abbot et al. (1984) reported hypoproteinaemia in lambs suffering from haemonchosis.

Pandey and Misra (1985) reported low total serum protein (4.99 ± 0.05) in all the affected cow-calves suffering from Ascariasis as compared to the healthy control values (6.3 ± 0.15). The electrophoretic pattern of serum protein showed decrease in albumin (34.13 ± 0.30%) with relative increase in the three fraction of globins (∝ 14.21 ± 0.22, β 12.82 ± 0.26 and γ 38.82 ± 0.28%).

Sarkar (1989) reported low total serum protein in grazing goat with parasitic load in Nadia district, West Bengal.

2.5.3 Status of serum iron

Iron deficiency seldom occurs in adult livestock, unless there is considerable blood loss from parasites or disease. Signs of lack of iron, in addition to anaemia and related blood changes, include lower weight gains, listlessness, inability to withstand circulatory strain, laboured breathing after mild exercise, reduced appetite and decreased resistance to infection (Miller et al., 1972 and McDowell et al., 1982). Iron requirements of ruminants are not well established ;

however, it is known that young animals have higher requirements than adults. For adult ruminant species, iron requirement is estimated to range from 20-50 ppm while the requirement for calves is thought to be 100 ppm (McDowell et al. 1982).

Taylor (1935) demanded that chronic blood loss in ruminants resulting from chronic bleeding due to heavy infestation of blood sucking parasites, deplete iron which was characterised by anaemia, poor growth and related production. The anaemia was caused by inadequate intake of iron, copper and cobalt and was marked by intestinal parasitism.

Maneko (1970) observed close relationship between the extent of morphological changes of blood cells in iron deficiency anaemia and the degree and the degree and severity of deficiency of iron in the body. He suggested that differential diagnosis of anaemia of varied cause could be made by finding decrease in serum iron increase in unsaturated iron binding capacity (UIBC) and decrease in iron stores together with the microcytic hypochromic anaemia. The normal serum iron increase in unsaturated iron binding capacity of healthy calves were reported to be 148 mg% ; corresponding values of healthy adult cows were 97 $\pm$ 29 gm% (57-162) and 131 $\pm$ 36 gm% (63-186).

Mollenburg (1974) reported that 3 to 35% of calves purchased in Sweden had iron deficiency anaemia. In these

calves which were kept on milk, hay and concentrates, the Hb and serum Fe values dropped during first ten months of life and thereafter the values gradually increased.

Underwood (1977) observed that high proportion of the total body Fe was present as circulating Hb. Therefore any condition influencing the level of Hb in the blood such as anaemia polycythemia etc. could greatly affect the Fe content of the body.

Dargie et al. (1979) reported on the basis of erythrokinetic study in experimental Trypanosoma brucei infection in cattle but the anaemia produced by this haemoprotozoan was of haemolytic origin and was due to impairment of iron reutilization from the degraded erythrocytes.

Pandey and Misra (1985) observed decrease of iron, unsaturated iron binding capacity (UIBC) and Total Iron Binding Capacity (TIBC) 111.36 ± 3.26, 115.75 ± 7.98 and 2.67 ± 8.37 respectively, in calves suffering from ascariasis.

Pandey and Misra (1987) reported increase in the value of iron and decrease in unsaturated and total iron, iron binding capacity in cattle suffering from haemolytic anaemia due to babesiosis.

Pandey and Misra (1987) reported increase value of serum iron with decrease in Unsaturated Iron Binding Capacity (UIBC) in anaemic buffalo cows suffering from nutritional haemoglobinuria.

Bhora et al. (1988) reported that for sheep grazing scrub permanent blood iron was 6.4 µg/ml. Corresponding value of iron for goats was 32.9 µg/ml.

Chopra and Harjit Kumar (1989) claimed that the normal iron requirement of cross-bred calves was 400 mg.

Hahn et al. (1990) reported serum iron content of 39 high-yielding cows from Bjelorara area in northern Yugoslavia of which 24 were infertile and 15 were healthy control, had a considerably higher iron level than normal and average 40-59 µ mol/litre.

2.5.4 Status of serum copper

Bennets and Beck (1942) reported that deficiency of Cu in cattle and ewes resulted hypochromic microcytic anaemia.

Becker et al. (1965) reported that occurrence of " Nutritional anaemia " in cattle running on certain fine sands, was due to inadequate intake of trace elements of which copper was one.

Pal et al. (1970) observed that Cu was important for the process of erythrogenesis in cattle.

Klimov and Polyakov (1971) reported disturbance of Cu metabolism in Theileria annulata infection in twenty-two young cattle. Abnormality in utilization and excretion of Cu was observed in cases of theileriasis in cattle. It was con-

sidered that low Cu levels in the liver and bone marrow of the affected cattle resulted in anaemia, contrary to earlier belief that anaemia was secondary to hypocupraemia.

Binot et al. (1972) reported mean plasma Cu in four young healthy cattle as 74.3 µg% .

Domanski et al. (1972) described the occurrence of anaemia in cattle and sheep due to deficiency of Cu.

Smith et al. (1972) observed the importance of Cu in prevention of anaemia in cattle as it was necessary for the utilization of Fe in the production of Hb.

Bodaf (1976) reported that Cu deficiency in blood serum causes recurrent reproductive disorders in cattle with high rate of mortality and morbidity in newborn calves.

Gardner et al. (1976) observed the association of post-parturient haemoglobinuria of dairy herd with low level of Cu in blood and liver and in pasture grazed upon. It appeared that the severity of Heinz body anaemia in this disease was related with the degree of hypocupraemia. The lower Cu status seemed to be related to pasture Mo and lime application.

Givens and Hopkins (1978) estimated Cu (mean 10.4 mg/kg DM) in 225 samples of herbage from 2 areas in North-Yorkshire with the history of bovine hypocupraemia.

Schwarz and Kirchgessner (1978) studied for 6 weeks with 75 high yielding cows and they were given daily supple-

mentary $CuSo_4$. H_2O and observed that plasma had Cu 0.95 to 1.18 µg/ml. The supplement had no significant effect on Cu.

Simek and Debek (1979) observed in new born calves of dairy cows, blood Cu concentration increased 1.5 fold as the intake by their mothers of the element was raised 1.5 fold.

Orsag et al. (1981) reported that though there was biochemical evidence of Cu deficiency among cows with pododermatitis, the Cu content of claw, horn was the same as that of healthy cows in same herds.

Clinical signs of Cu deficiency include scours, pale membranes of the eyes and mouth, rough and bleached hairs, slow growth and loss of body weight (Blood et al., 1983).

Lamand (1985) experimentally established that there was marked anaemia with other symptoms after feeding of diet deficient in Cu in goat.

Keen and Feldman (1987) analysed blood samples from 5 cattle for Cu by A.A.S. Mean Cu concentrations within species were similar for serum, heparin plasma and EDTA plasma.

Kleczkowski (1987) studied biochemically Cu deficiency with high level of molybdenum and normal level of Zn in blood serum and also recorded low level of Ca, P, S in Cu deficiency in soil.

Pandey and Misra (1987) reported marked decrease in

serum Cu (63.03 ± 6.24 to 70.908 ± 4.033 mg%) in anaemic buffalo cows suffering from nutritional haemoglobinuria.

Sas (1987) reported death in cows near a tractor repair yard due to secondary Cu deficiency caused by pasture contaminated with oil containing molybdenum bisulphide. He examined two cows and found serum Cu values of 0.15 and 0.2 mg/lt and ceruloplasmin activities of 2.6 and 6.6 IU/Lt.

Bhora et al. (1988) observed in sheep grazing scrub and permanent pastures blood Cu was 3.2 and 4.8 µg/ml. Corresponding value for goats was 2.8 and 3.4 µg/ml.

Cridland (1988) measured the Cu value in serum indicating widespread deficiency of Cu was not thought to be limiting the productivity of ruminants in Pupa, New Guinea.

Damir et al. (1988) observed some clinical cases of Cu deficiency in cattle farm in Kordafan Region of Sudan after drought. The animals showed general weakness, stunted growth, infertility, parakeratosis and achormotrichia. There was macrocytic hypochromic anaemia and low Cu concentration in sera. Draught and marginal low Cu content in pasture may be the predisposing factors.

Kleszowski (1988) estimated Cu concentration in the soil hervage, serum, liver kidneys, brains, skeletal muscles and long bones of cattle. No relationship was found between Cu content in soil and in liver which seemed to depend on other factors.

Balbuena et al. (1989) measured Cu in samples of serum, liver and hairs (218, 208 and 69 respectively) of beef cattle and in samples of soil and forage (31 and 311) from 11 farms in 3 ecologically homogenous areas in the eastern area of Chaco and Formosa Provinces, Argentina, during November and December (1985). Cu was greater in serum and liver samples from Formosa Province than in those from Chaco Province. Cu was below 0.3 mg/litre in 50% of serum sample and less than 25 mg/kg in 55.2% of liver samples.

Sarkar (1989) measured Cu concentration in serum of grazing goats of Nadia district, ranged from 83.57 to 113.08 µg%.

Chopra and Kaur (1989) reported that Cu requirement of cross-bred calves was 20 ppm.

Hahn et al. (1990 estimated Fe and Cu in the serum of 39 high yielding cows from Bjelovara area in northern Yugoslavia of which 24 were infertile and 15 were healthy control. All cows had a considerably higher Fe content than normal an average 40.59 µ mol/litre, while Cu content was low and average 10.74 µ mol/litre.

2.5.5 Status of serum molybdenum

Kleczkowski (1987) studied biochemically Cu deficiency with high level of Mo and normal level of Zn in blood serum and also reported low level of Ca, P, S in Cu deficiency in soil and herbage.

Sas (1987) examined two cows for serum Cu values of 0.15

and 0.2 mg/litre and ceruloplasmin activities of 2.6 and 6.6 IU/litre, while Mo values of rumen contents were 21 and 27.76 mg/kg.

Balbuena et al. (1989) measured Mo in samples of serum liver and hair (218, 208 and 69 respectively) of beef cattle and in samples of soil and forage (31 and 311) from 11 farms in 3 ecologically homogenous areas in the eastern area of Chaco and Formosa Provinces, Argentina, during November and December, 1985. There was a significant interaction between ecological area and soil type for Cu and Mo in forage. Mo was more than 6 mg/kg and S more than 0.4% in 28 and 62% samples respectively.

2.5.6 Status of serum cobalt

Reid (1923) described the clinical symptoms of Co deficiency among affected cattle and sheep as progressive anaemia, emaciation, loss of energy, exhaustion and death. It is reported that the clinical symptoms appear in about five months time after allowing the animals to live in deficient pastures.

Filmer (1933) reported Co deficiency in sheep and cattle grazing in the Denmark district near South Coast of Australia properly known as " Enzootic Marrasmas ". The young cattle and sheep were more severely affected than adults. Even sheep seemed to be more susceptible than cattle. The clinical symptoms observed by them were loss of appetite, pica, progressive emaciation, anaemia and death. Young calves showed diarrhoea more commonly than adult cattle. Similar condition in sheep known as nutriti-

onal anaemia was also noticed by them in the areas of New South Wales but no reference was then made to Co deficiency.

A condition similar to " Enzootic Marrasmas " in South Australia was recorded by Marston and McDonald (1938) as 'Coast Disease' .

Bendexan and Pedersen (1945) reported outbreak of Co deficiency in cattle grazing in sandy soil of Jutland, Denmark, They observed calves between 2-4 months of age showed progressive loss of appetite, pica, stunted growth, loss of weight and emaciation. They developed coarse dirty and starring coat with long hairs. The affected animals got exhausted ; dry pelleted to mucus coated faeces was seen. Diarrhoea was seen in exhausted animals before death.

Lee (1950) observed that young growing animals have been severely affected when reared on deficient pastures. Young growing sheep were sensitive to Co deficiency followed by mature sheep, calves and adult cattle in order. In severe Co deficiency there is extreme emaciation, listless, sleepy look, long hairs, starved condition. The mucus membranes were bleached, skin pale and fragile, progressive anaemia, stunted growth, constipation, pelleted faeces with intermittent diarrhoea at late stages, impaired growth were also reported.

Russel and Duncan (1956) reported that similar condition of Co deficiency in cattle , sheep and goats known as " Licking Disease " was observed by Brinkman and Sjollema

gradually loose appetite and failure of growth or loss of weight, followed by extreme loss of appetite, rapid muscular weasting, depraved appetite, severe anaemia and death. If deficiency is mild or marginal, the above clinical signs may never occur and only the young, most susceptible animals may exhibit signs of unthriftiness which are indistinguishable from the effects of parasitism or low feed intake (McDowell et al., 1983).

Lamand (1985) conducted experiments with diets deficient in Co resulting in gradual reduction of appetite, progressive emaciation and anaemia in goats.

Movsum-Zade (1986) reported the clinical cases of Co deficiency preceded by decreased concentration of Co in blood. The disorder hypocobaltosis develops in 2 stages, subclinical when blood Co value upto 1 µg/100ml and clinical when it was below 1 µg/100 ml. For healing and preventing hypocobaltosis it was essential to use not only Co but also Cu, Fe and a preparation of proteins and vitamins.

Lunden et al. (1989) estimated Cu and Co status of 232 slaughtered lambs in Sweden and found unsatisfactory Co level or Co deficiency.

2.5.7 Status of serum manganese

Bodi (1976) reported the deficiency of Mn in blood causing reproductive disorder of cows and mortality and morbidity of calves.

Keen and Feldman (1987) studied blood samples of 5 cattle for Zn by AAS Zn concentration within species were similar for serum and heparin plasma but were much higher for EDTA plasma.

Bhora et al. (1988) reported the mineral status of sheep and goats grazing, scrub forest and permanent pasture in Jodhpur. The blood Zn was found 8.4 and 6.4 µg/ml in sheep and 8.9 and 9.7 µg/ml in goat respectively.

Cridland (1988) recorded the mineral status of domestic livestock in Pupa, New Guinea and found widespread deficiency of Zn.

Damir et al. (1988) studied the clinical cases of Zn deficiencies in cattle in Kordofan-region of Sudan after draught. There was macrocytic hypochromic anaemia and low Zn concentration in sera.

Kleszowski (1988) estimated Zn concentration of soil and herbages and also in blood serum, skeletal muscles in 10 cattle and recorded large Zn pool in all tissues of animals.

Milhaud and Mehennaoui (1988) measured Zn in blood serum in Dairy cattle on a farm located in the vocinity of a Zn or processing factory for 21 months and reported that Zn protoporphyrin with mean values of 165 µg/100 ml blood. Blood Zn concentration and Zn protoporphyrin concentration were not significantly increased.

Darmono et al. (1990) estimated the serum Zn levels of 47 slaughterhouse buffalo and grazing sheep fall into the marginal zones, less than 0.8 ppm but above 0.4 ppm, suggesting suboptimal Zn status.

CHAPTER III

MATERIALS AND METHODS

3.1 Trace minerals status of soil in grazing field

3.1.1 Collection of soil sample for analysis

The soil samples for analysis were collected from the grazing field of cattle in and around Narangadighi, Midnapore district, West Bengal.

The profile pit was excavated deep enough (6" X 1") so that profile was uniformly lighted and to reveal the principle features and to extend down to the parent material. Each soil sample thus collected was placed in a double-walled cloth or paper bag. The bag was labelled and a file card was dropped into it, bearing the area, date of collection and sample No. After well packaging, the bags were then despatched to the laboratory for analysis.

The soil samples were then air-dried at a temperature of about 25°C to 35°C. The bulk soil samples for chemical analysis was passed through a 2 mm. (10 meshes per inch) sieve, usually by rubbing with fingers or with the use of grinders or pestle and mortur (Jackson, 1967).

3.1.2 pH of the soil sample

10 gms. of soil kept in a 50 ml beaker and 25 ml of tripple distilled water was added ot it (soil : water ratio,

1 : 2.5).

The suspension was stirred at a regular interval for 20-30 minutes. The equilibrium attained within 5 minutes of continuous vigorous shaking with a reciprocating mechanical shaker and it was kept rest for overnight. Then the pH was measured with the glass electrodes (Jackson, 1967).

3.1.3 Preparation of DTPA solution

The soil samples were extracted with DTPA (diethylene triamine penta acetic acid).

The extractant used in this investigation was prepared according to procedure developed by Lindsay and Norvell (1969). The extractant was prepared by mixing DTPA, $CaCl_2$ and triethanolamine (TEA) in such a proportion as to get a solution containing 0.005 M DTPA, 0.01 M $CaCl_2$ and 0.1 M TEA in it. For this purpose 7.62 ml of penta sodium salt of DTPA (33% solution) and 13.29 ml of triethanolamine (density 1.22 gm/ml) were taken in 1 litre flask, 1.47 gm of $CaCl_2$. 2 H_2O was taken in the same volumetric flask and volume was made upto 1 litre with deionized water. The solution was mixed thoroughly and the pH was adjusted to 7.3 by adding HCl (diluted) acid before the the volume was made up.

3.1.4 Extraction procedure

10 gms of soil sample was taken in a test tube, 20 ml of DTPA extractant was added to it, corked tightly and shaked

3.1.9 Status of manganese in soil

The extracted soil samples with DTPA were used for the estimation of manganese content in the soil and the value was expressed in terms of µg/g or ppm.

3.1.10 Status of zinc in soil

The same extracted soil samples with DTPA were used for the estimation of zinc content in the soil. The value was expressed in terms of µg/g or ppm.

3.2 Trace mineral status of plants in the grazing field

The grasses and leaves of the shrubs of the pasture land grown in the soil of the grazing area of cattle around Narangadighi, Midnapore district, West Bengal, were collected in an envelop containing sample No., date and area of collection for each sample. Each sample was divided into two parts, one for identification which was placed in blotting paper and other for sample analysis. The identification was done by Dr. S.P. Bandopadhya, Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya. The other sample meant for analysis, was put in a hot airoven at 100°C for drying up of the sample and the samples were processed further as per method described AOAC (1970) for analysis of iron, copper, molybdenum, cobalt, manganese and zinc.

3.2.1 Extraction procedure

Oxidation of the organic matter of the plant tissue and release of the mineral elements was effected through wet oxida-

tion by means of oxidizing acid such as HNo_3, H_2So_4, $HClo_4$ acid mixture in the ratio of 10 : 1 : 4 respectively.

0.5 gm of the dried plant sample was taken in a 100ml conical flask. 10 ml of tri-acid mixture was added to it. It was kept for overnight. Then digestion was completed on hot plate at 180-200°C dense white fumes of H_2So_4 and $HClo_4$. The content in the flask after digestion was transformed to mineral crystals of each sample. Then it was made cooled. Then it was transferred to 50 ml volumetric flask by several washings through Whatman No. 42, filter paper. Washing of each sample was done by tripple distilled water and made up the final volume to 50 ml (Jackson, 1967).

Now the extractant was subjected to estimation of Fe, Cu, Mo, Co, Mn and Zn. With the help of AAS and the value was expressed in terms of µg/g or ppm.

3.2.2 Status of iron in plants

The above extractant was used for the estimation of iron in the plants in AAS and value was expressed in terms of µg/g or ppm.

3.2.3 Status of copper in plants

The same extractant was used for the estimation of copper in the plants in AAS and value was expressed in terms of µg/g or ppm.

haemoprotozoan parasites in blood. Since, the cattle had varrying degree of gastro-intestinal parasitic infection as evident from faecal sample examination, they were treated with Ivermectin (1%) at the dose rate of 200 µg/kg body weight injected subcutaneously, once. Subsequent faecal examination at 7, 14 and 21 days post treatment revealed negative results and the cattle were 100% free of gastrointestinal parasites (Najanja et al., 1987). The animals of control group were maintained on grazing, browsing with concentrates, feed additives and vitamins to bring them to normal condition at the earliest before the start of the actual research work. Fresh and clean drinking water was provided adlibitum to the cattle. Blood samples for haematological and biochemical profiles were examined at every fortnight and the values were compared with the values of grazing cattle of Midnapore district, West Bengal.

3.3.2 Clinical manifestation of cattle

The cattle of Midnapore district, West Bengal from villages like Narangadighi, Bagnabard, Barisha, Jalchak and Naya were clinically examined for anaemia, diarrhoea, anorexia, stunted growth, loss of milk yield, delayed oestrus, anoestrus, repeat breeding, rough body coat etc. The cattle were divided into six groups : gr. I (Anaemia with parasitism), gr. II (Anaemia without parasitism), gr. III (Anoestrus with reproductive disorders), gr. IV (Anoestrus without reproductive disorders), gr. V (Non specific disease syndrome) and gr. VI (Repeat breeding)clinically. The cattle were also divided into four groups

on the basis of feeding habbit :

gr. A - (Stall feeding)

gr. B - (Stall feeding with concentrates)

gr. C - (Grazing with concentrate)

and gr. D - (Grazing).

3.3.3 Prevalence

Clinically ill cattle according to the symptoms noticed during the present study under field condition were divided into six groups. gr. I, Anaemia due to parasitism having the symptoms like increased heart rate, increased respiration, paleness of eye mucous membrane etc. gr. II, Anaemia without parasitism (supposed to be nutritional anaemia), gr. III, Anoestrus with reproductive disorders, gr. IV, Anoestrus without reporductive disorders, gr.V, Non specific disease syndrome - like inappetance, diarrhoea, poor body growth, rough skin coat, poor milk yield etc.& gr. VI, Repeat breeding.

3.3.4 Examination of faecal samples of cattle

Faecal samples of all such cattle were collected in glass container (small vials) and subjected to faecal report. The faecal examination was done by microscope (low power) for the detection of parasitic ova/oocyst as per methods described by Soulsby, 1982.

3.4 Haematological changes in cattle blood

3.4.1 Collection of blood from cattle for analysis

Blood samples in three separate screw-capped containers

previously cleaned with tripple distilled water and air dried, were collected from each cattle.

In the first container, EDTA was used as anticoagulant and immediately after collection the content was mixed by gentle horizontal rotation. This first container was ready for following haematological study :

Haemoglobin (Hb)
Packed cell volume (PCV)
Total Erythrocytic Count (TEC)
Total Leucocytic Count (TLC)
Differential Leucocytic Count (DLC)

3.4.2 Haemoglobin (Hb)

Hb was determined by Sahlis's method as described by Schalm et al. (1975) and the results were expressed as g%.

3.4.3 Packed cell volume

PCV was determined in mm by micro-haematocrit method and results were expressed as percentage of total volume (Schalm et al., 1975).

3.4.4 Total erythrocytic count

TEC was done by haemocytometer as described by Schalm et al. (1975) and value was expressed as millions per cubic millimeter (10^6/Cmm.).

jected to estimation of serum protein, serum iron (SI), serum copper (SCu), serum Molybderum (SMo), serum cobalt (SCo), serum Manganese (SMn) and serum Zinc (SZn).

3.5.2 Estimation of serum protein

Serum protein was estimated as per method described by Reinhold et al. (1950) and value was expressed as g%.

3.5.3 Estimation of serum iron (SI)

SI was estimated as per method described by Sandel (1950) and Arenzol et al. (1977) utilizing Atomic Absorption Spectrophotometer. A known volume of serum was digested with double the volume of tri-acid mixture (HNo_3 10 parts, $Hclo_4$ 4 parts and H_2So_4 1 part) on hot plate and dilution to a known concentration was made with deionised water. There was a clear solution of digested serum and was processed in AAS (Perkin Elmer) with standard solution of different concentrations of iron in order to estimate the final concentration of iron in the serum and value was expressed as µg%.

3.5.4 Estimation of serum copper (SCu)

SCu was estimated from the above mentioned clear solution in the AAS with the standard dilution of different concentrations of copper. The value was expressed as µg%.

3.5.5 Estimation of serum molybderum (SMo)

The same method was followed as estimation of iron or

copper in AAS and value was expressed as µg% .

3.5.6 Estimation of serum cobalt (SCo)

For the estimation of serum cobalt, the same method was applied as in serum iron, serum copper and serum molybdenum and results were expressed as µg% .

3.5.7 Estimation of serum manganese (SMn)

For the estimation of serum manganese, the same method was followed as in serum iron and value was expressed as µg%.

3.5.8 Estimation of serum zinc (SZn)

For the estimation of serum zinc, the same method was followed as in serum iron and serum copper in AAS and the value was expressed as µg%.

3.6 Therapeutic measures of cattle

All the clinically ill cattle positive to parasitic infection were administered with anthelmintic drugs. Supplementation with trace minerals like iron, copper and cobalt to the cattle of various groups for a period of 1 month proved very effective. The progress of the treatment at intervals after the start of the treatment was presented in table 10 & 11.

The animals of gr.IV (anoestrus without reproductive disorder) were subjected to ovary massage twice in a week along with supplementation of trace minerals.

In case of repeat breeding animals (gr. VI), intrauterine infusion of antibiotics was given before supplementation of trace minerals.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Trace minerals status of soil in grazing field

The detailed results of analysis of soil samples in relation to pH, Fe, Cu, Mo, Co, Mn and Zn from the grazing fields were presented in table 1 .

4.1.1 pH of the soil samples

The pH of the soil samples of the grazing area of animals varied between 7.63 to 10.9 (average 8.15). The majority of the soil samples analysed from different areas of the grazing field indicated alkaline pH.

McDowell *et al.* (1984) observed that the increase of soil pH, the availability and uptake of iron (Fe), manganese (Mn), Zinc (Zn), Copper (Cu), and Cobalt (Co) decrease whereas molybdenum (Mo), and selenium (Se) concentrations increase.

4.1.2 Status of iron in soil

The iron content in the soil of the grazing area of animals was found to be in the range of 218.24 ± 1.11 ppm to 742.56 ± 3.22 ppm (average 405.79 ± 1.81 ppm) which contradicted with the reports of Pal *et al.* (1982), Saha *et al.*(1982), Anon (1983), I.C.A.R. Report (1983-84), Brun *et al.* (1987) and Sarkar (1989) possibly due to agroclimatic variation.

4.1.3 Status of copper in soil

The analytical result of Cu content in soil of the

Table 1. Trace minerals status of

Area of collection of soil samples	pH of the soil samples	Iron(Fe) ppm=µg/gm	Copper(Cu) ppm=µg/gm
1	2	3	4
Bagnabard (West)	8.35	385.79 ±1.22	3.606 ±0.32
Bagnabard (East)	7.90	526.45 ±1.24	2.892 ±0.22
Bagnabard (North)	7.90	468.38 ±0.89	3.249 ±0.12
Bagnabard (South)	8.10	364.85 ±1.26	2.249 ±0.14
Bagnabard (Central)	7.70	606.04 ±3.22	4.106 ±0.78
Barisha (West)	7.90	409.36 ±1.22	3.820 ±0.26
Barisha (East)	8.10	396.98 ±2.55	3.999 ±0.56
Barisha (North)	8.40	479.80 ±1.68	4.285 ±0.23
Barisha (South)	8.13	459.57 ±1.27	3.249 ±0.17

soil samples in grazing field

Molybdenum (Mo) ppm=µg/gm	Cobalt(Co) ppm=µg/gm	Manganese (Mn) ppm=µg/gm	Zinc(Zn) ppm=µg/gm
5	6	7	8
5.62 ±0.34	1.92 ±0.26	43.55 ±1.95	1.195 ±0.12
5.87 ±0.36	1.16 ±0.15	44.36 ±2.16	2.233 ±0.22
4.28 ±0.16	0.86 ±0.12	42.58 ±2.12	2.236 ±0.18
3.48 ±0.17	2.62 ±0.71	31.88 ±1.12	1.094 ±0.26
2.96 ±0.19	1.78 ±0.12	38.36 ±1.92	2.885 ±0.09
3.67 ±0.22	2.62 ±0.17	44.47 ±1.22	1.203 ±0.22
3.48 ±0.24	2.66 ±0.11	43.55 ±1.62	1.073 ±0.16
5.78 ±0.34	2.61 ±0.62	44.55 ±1.11	1.275 ±0.36
2.98 ±0.39	2.23 ±0.42	42.74 ±1.32	2.287 ±0.12

Contd.....

1	2	3	4
Jalchak (West)	8.10	388.41 ±1.24	2.928 ±0.22
Jalchak (East)	7.63	408.64 ±0.86	3.642 ±0.56
Jalchak (North)	7.83	483.61 ±4.72	3.428 ±0.32
Jalchak (South)	9.00	363.18 ±1.68	3.999 ±0.11
Narangadighi (West)	7.80	301.30 ±2.54	3.606 ±0.23
Narangadighi (East)	7.80	219.67 ±1.07	2.928 ±0.26
Narangadighi (North)	7.92	248.71 ±1.82	1.852 ±0.08
Narangadighi (South)	8.50	267.03 ±0.92	3.785 ±0.41
Narangadighi (Central)	8.40	218.24 ±1.11	3.997 ±0.26

Table 1 (Contd.....

5	6	7	8
2.78 ±0.16	2.17 ±0.42	43.50 ±1.57	1.20 ±0.39
4.26 ±0.35	3.78 ±0.72	45.20 ±1.62	2.818 ±0.12
4.62 ±0.14	3.12 ±0.26	44.63 ±1.92	2.329 ±0.22
2.76 ±0.22	0.89 ±0.12	41.12 ±1.72	1.201 ±0.08
5.34 ±0.26	1.36 ±0.42	43.82 ±1.92	1.584 ±0.19
4.59 ±0.24	2.69 ±0.72	40.12 ±1.76	0.891 ±0.02
4.86 ±0.27	2.19 ±0.42	43.16 ±1.92	3.587 ±0.12
2.78 ±0.19	3.92 ±0.62	43.15 ±1.62	1.725 ±0.22
3.22 ±0.23	0.26 ±0.11	43.96 ±1.78	1.198 ±0.26

Contd.....

1	2	3	4
Naya (West)	7.63	408.80 ±1.67	3.9[illegible] ±0.27
Naya (East)	8.10	364.14 ±2.23	3.606 ±0.17
Naya (North)	7.33	416.02 ±2.24	3.928 ±0.22
Naya (South)	10.90	742.56 ±3.22	2.928 ±0.19

Table 1 (Contd.....

5	6	7	8
5.92 ±0.36	3.72 ±0.32	45.09 ±1.16	1.072 ±0.12
4.92 ±0.26	1.82 ±0.41	44.96 ±2.12	0.90(±0.26
5.39 ±0.32	3.17 ±0.16	42.74 ±1.72	2.36(±1.26
4.12 ±0.22	2.68 ±0.32	44.90 ±1.22	0.946 ±0.67

grazing fields of the animals was 1.852 ± 0.08 ppm to 4.285 ± 0.23 ppm (average 3.455 ± 0.27 ppm), which were definitely lower than the normal values of about 9.00 ppm as reported by Kanwar (1964), Randhawa and Kanwar (1964).

This observation of low level of Cu in the soil is possibly due to deficiency of the element in the parent rock or leaching of soil resulted from heavy rain fall, McDowell (1985).

4.1.4 Status of molybdenum in soil

The Mo status in soil samples of the grazing field of animals varied between 2.76 ± 0.22 ppm to 5.92 ± 0.36 ppm (average 4.25 ± 0.25 ppm).

The analytical result of Mo status in soil was in the normal range as per recommendation made by NRC (1978) and Blood et al. (1983). The present results indicated that there was no interaction of Mo with Cu in soil.

4.1.5 Status of cobalt in soil

The Co content in the soil of the grazing area of animals was found to be in the range of 0.26 ± 0.11 ppm to 3.92 ± 0.62 ppm (average 2.28 ± 0.35 ppm).

The results of the analysis of Co in soil were very low against the normal level of Co in the soil, Davison and Mitchell (1940). The nutritional disorders among the livestock reared only on grazing and browing could be expected in areas where total Co content of the soils were less than the

average values (Davison and Mitchell, 1940) and McDowell (1985). It is also suggested that soil analysis is always preferred to that of forage analysis to establish the trace elements deficiency, particularly of Co.

4.1.6 Status of manganese in soil

The estimation of Mn in the soil of the grazing field of animals was 31.88 ± 1.12 ppm to 45.20 ± 1.62 ppm (average 42.33 ± 1.66 ppm), which revealed low Mn content in the soils of the grazing area when compared with the status of Mn content in the soils of other parts of West Bengal 140 to 1320 ppm (Dhamija et al. 1956b), and in Punjab 288 to 922 ppm (Randhawa et al. 1961).

4.1.7 Status of zinc in soil

The Zn status of soil samples of the grazing field of animals varied between 0.89 ± 0.02 ppm to 3.58 ± 0.12 ppm (average 1.68 ± 0.25 ppm), which simulated with the reports of Sarkar (1989).

Bokede (1960) described that available zinc content of Indian soil varied from 2.5 to 6.05 ppm. The zinc content of soil was normal as per the indication that the critical soil Zn concentration for plants in 1.5 ppm (Sanchet, 1975 ; NRC , 1955 ; and Chatterjee and Das, 1964). They reported higher Zn level in the soil of other states of India.

4.2 Trace minerals status of plants in grazing field

The list of the grasses including plants with their scientific names were listed and the results of the analysis of these grasses and plant samples of the grazing field of the animals were presented in table 2 .

4.2.1 Status of iron in plants

The Fe content in grasses and plants of the grazing field of animals was found to be in the range of 499.99 ±1.79 ppm to 3473.27 ± 5.62 ppm (average 999.34 ± 3.46 ppm) and 343.51 ± 1.62 ppm to 3175.56 ± 5.62 ppm (average 1624.25 ± 2.95 ppm) respectively.

The present analysis of Fe content in plants were in close similarity with those reported by Aiyer (1948) in rice straw. Sawhney *et al.* (1977) reported that the value of Fe in grass between 144.23 ppm to 502.97 ppm and that of legume fodder between 229.11 ppm to 514.29 ppm. Sarkar (1989) reported that the Fe content in pasture samples of the grazing field of Nadia district of West Bengal within the range of 360.44 ppm to 3142.16 ppm. The present study indicated, Fe content in plants showed excess Fe than grasses. Natural feed stuff usually contain enough iron to meet the requirements of farm livestock (McDowell and Conrad, 1977). NRC (1978) also made dietary recommendation of 50 ppm of iron to prevent iron deficiency in cattle. The present findings suggested that the status of iron in plants of grazing area was adequate to pre-

Table 2 : Trace minerals status of pasture samples in grazing field

Area of collection of pasture samples	Scientific name of the pasture (grasses and plants) samples	Iron(Fe) ppm=µg/gm	Copper(Cu) ppm=µg/gm	Molybdenum (Mo) ppm=µg/gm	Cobalt (Co) ppm=µg/gm	Manganese (Mn) ppm = µg/gm	Zinc(Zn) ppm=µg/gm
1	2	3	4	5	6	7	8
Bagnabard (West)	Cyanodon dactylon	499.99 ±2.32	32.56 ±1.12	1.02 ±0.21	0.04 ±0.01	53.57 ±0.18	48.58 ±0.23
Bagnabard (East)	Cyanodon dactylon	729.00 ±3.22	36.39 ±1.62	0.86 ±0.04	0.06 ±0.02	64.28 ±0.16	52.03 ±0.42
Bagnabard (North)	Cyanodon dactylon	1236.64 ±5.62	17.24 ±1.52	0.89 ±0.05	0.09 ±0.04	49.99 ±0.17	31.66 ±0.12
Bagnabard (South)	Cyanodon dactylon	564.88 ±2.46	24.90 ±1.22	1.02 ±0.21	0.16 ±0.84	53.57 ±0.16	48.58 ±0.16
Barisha (West)	Cyanodon dactylon	499.99 ±1.79	32.56 ±2.11	0.89 ±0.04	0.04 ±0.01	53.57 ±0.23	48.58 ±0.26
Barisha (East)	Cyanodon dactylon	729.00 ±3.24	36.39 ±2.51	0.87 ±0.03	0.05 ±0.03	64.28 ±0.22	52.03 ±0.42
Barisha (North)	Cyanodon dactylon	580.15 ±2.26	17.24 ±1.62	1.02 ±0.22	0.18 ±0.02	144.04 ±0.18	31.66 ±0.21
Barisha (South)	Cyanodon dactylon	729.00 ±3.12	22.98 ±1.22	0.84 ±0.02	0.04 ±0.01	49.99 ±0.17	29.46 ±0.42

Contd.....

1	2	3
Jalchak (East)	Cyanodon dactylon	580.15 ±1.69
Jalchak (North)	Cyanodon dactylon	580.15 ±1.62
Narangadighi (West)	Cyanodon dactylon	1225.18 ±5.22
Narangadighi (East)	Cyanodon dactylon	870.23 ±3.42
Narangadighi (North)	Cyanodon dactylon	763.35 ±4.12
Narangadighi (South)	Cyanodon dactylon	1110.68 ±5.22
Narangadighi (Central)	Cyanodon dactylon	1187.02 ±5.24
Naya (West)	Cyanodon dactylon	824.42 ±4.29
Naya (North)	Cyanodon dactylon	779.02 ±3.22

Table 2 (Contd.....

4	5	6	7	8
13.83 ±1.04	0.85 ±0.01	0.06 ±0.02	334.52 ±0.23	32.60 ±0.24
22.98 ±1.66	1.02 ±0.22	0.15 ±0.62	86.90 ±0.16	38.24 ±0.34
22.98 ±0.92	0.84 ±0.04	0.08 ±0.04	142.85 ±0.24	52.03 ±0.48
22.98 ±1.52	0.89 ±0.06	0.04 ±0.02	144.04 ±0.24	42.31 ±0.46
32.56 ±1.11	1.01 ±0.24	0.09 ±0.07	236.90 ±0.23	81.19 ±0.52
32.56 ±0.98	1.02 ±0.22	0.12 ±0.86	49.99 ±0.16	49.21 ±0.19
21.07 ±1.29	0.89 ±0.06	0.11 ±0.84	103.57 ±0.16	41.69 ±0.46
32.56 ±1.62	0.86 ±0.06	0.12 ±0.11	79.76 ±0.16	71.47 ±0.24
13.40 ±1.12	1.01 ±0.24	0.04 ±0.02	144.04 ±1.20	29.46 ±0.41

Contd.....

1	2	3
Naya (South)	Cyanodon dactylon	3290.07 ±6.22
Bagnabard(South)	Cyperus radiatus	492.36 ±2.26
Bagnabard(Central)	Echinochloa colona	1110.68 ±5.12
Jalchak(West)	Saccharum spontanum	564.86 ±1.29
Narangadighi (East)	Cyalotis axillaris	3473.87 ±5.62
Naya(East)	Brachiaria ramosa	564.88 ±1.22

Table 2 (Contd.....

4	5	6	7	8
17.24 ±0.92	0.84 ±0.06	0.13 ±0.84	64.28 ±0.62	41.69 ±0.19
30.65 ±1.12	1.01 ±0.24	0.08 ±0.02	103.57 ±1.01	53.28 ±0.55
30.65 ±1.04	0.86 ±0.04	0.04 ±0.01	249.99 ±0.82	42.31 ±0.32
36.39 ±1.19	1.01 ±0.26	0.09 ±0.06	145.23 ±0.62	49.21 ±0.57
30.65 ±0.76	0.86 ±0.06	0.16 ±0.86	233.33 ±1.22	67.39 ±0.24
36.39 ±1.12	1.02 ±0.26	0.17 ±0.86	145.23 ±0.84	49.21 ±0.16

Contd.....

Table 2 (Contd.....

1	2	3	4	5	6	7	8
Bagnabard (North)	Blumea lacera	553.43 ±1.52	17.66 ±0.28	2.01 ±1.21	0.24 ±0.11	840.47 ±1.22	31.97 ±0.42
Jalchak (North)	Vernonia cinerea	1795.63 ±3.22	32.56 ±0.76	1.02 ±0.28	0.26 ±0.12	333.33 ±1.11	64.57 ±0.37
Narangadighi (West)	Boreria hispida	2553.43 ±4.12	22.98 ±1.15	2.10 ±1.20	0.28 ±0.14	114.28 ±1.02	85.26 ±0.24
Narangadighi (East)	Cucumis sativa	1793.89 ±3.12	21.07 ±1.07	2.12 ±1.12	0.27 ±0.12	95.23 ±0.22	53.28 ±0.41
Narangadighi (North)	Crotolaris juncea	3175.56 ±5.62	34.48 ±1.62	2.26 ±1.26	1.20 ±1.12	101.18 ±1.12	48.58 ±0.24
Narangadighi (Central)	Eupatorium odoratum	1793.89 ±3.12	30.65 ±1.12	3.01 ±1.42	2.30 ±1.20	53.57 ±0.68	69.90 ±0.17
Naya(West)	Cassia sophera	984.73 ±1.29	32.56 ±1.22	2.02 ±1.12	2.45 ±1.24	249.99 ±1.22	71.47 ±0.42
Naya(East)	Phaseolus trilopus	343.51 ±1.62	34.48 ±0.25	2.03 ±1.13	4.60 ±1.64	95.23 ±0.68	69.27 ±0.41

vent Fe deficiency.

4.2.2 Status of copper in plants

The results of the analysis of grasses and plants samples of the grazing field of animals showed 13.40 ± 1.12 ppm to 36.39 ± 1.62 ppm (average 25.29 ± 1.31 ppm) and 17.66 ± 0.28 ppm to 34.48 ± 1.62 ppm (average 27.05 ± 0.93 ppm) respectively.

Sarkar (1989) observed that the Cu content in plants of the grazing field of animals was found to be in the range of 23.52 ± 0.17 ppm to 125.61 ± 0.35 ppm. Kanwar (1978) reported that the dietary recommendation of Cu content of legumes, cereals, fodder crops (non legumes)and vegetables were reported to be 9.5 ppm to 17.5 ppm, 12.5 ppm to 29.6 ppm, 6.0 ppm to 29.2 ppm and 8.8 ppm to 22.7 ppm respectively.

The results indicated that grasses contained Cu less than that of plants. The results of the present study did not show any deficiency of Cu either in plants or grasses of the grazing field as NRC (1978) recommended 10 ppm Cu for the maintenance of animals.

Though the Cu content of soil was marginal to low, it was found that the Cu content of plants was within the normal range. This is likely due to the availability and mineral uptake of plants from soils (McDowell *et al.* 1982).

4.2.3 Status of molybdenum in plants

The estimation of Mo in grasses and plants of the

grazing field of animals were 0.84 ± 0.02 ppm to 1.02 ± 0.22 ppm (average 0.93 ± 0.16 ppm) and 1.02 ± 0.28 ppm to 3.01 ± 1.42 ppm (average 2.07 ± 1.26 ppm) respectively. The findings bear similarity with the reports of Reddy (1964) and Mehta et al. (1969). Pastures containing more than 10 ppm is dangerous for livestock (Blood et al., 1983) as it interacts with the uptake of Cu by the animals. The results of the present study did not show any excess content of Mo of plants.

4.2.4 Status of cobalt in plants

The results of the analysis of grasses and plants samples of the grazing field of animals showed 0.04 ± 0.02 ppm to 0.18 ± 0.02 ppm (average 0.093 ± 0.06 ppm) and 0.24 ± 0.11 ppm to 4.60 ± 1.64 ppm (average 1.45 ± 0.82 ppm) respectively.

Young (1948) and NRC (1978) observed that 0.10 ppm to 0.17 ppm of cobalt is the normal range in plants for the normal health of cattle. Dutta and Datta Biswas (1951) observed that all grasses had high Co content but with the increase in age they found gradual decrease in Co content. Iyer (1958) reported, legume has marked concentration of Co than the grasses. Blood et al. (1983) reported that pastures containing less than 0.07 ppm and 0.04 ppm of Co on dry matter basis lead to development of clinical signs of Co deficiency in sheep and cattle respectively. The present study showed a marked deficiency of Co in grasses.

SMo, SCo, SMn, and SZn of cattle of control group were 14.10 ± 0.41 g%, 39.42 ± 0.44%, 8.34 ± 0.07 million/Cmm, 8.27 ± 0.08 thousand/Cmm, DLC (30.29 ± 0.25% N, 3.20 ± 0.08% E, 0.05 ± 0.01% B, 62.62 ± 0.25% L and 3.68 ± 0.24% M), 55.82 ± 0.46 mg%, 7.62 ± 0.18 g%, 378.42 ± 5.17 µg%, 188.45 ± 1.25µg% 17.42 ± 0.25 µg%, 37.24 ± 0.16 µg%, 127.82 ± 0.18 µg% and 384.24 ± 5.41 µg% respectively. The results of the analysis were presented in table 3 and table 7 .

4.3.2 Status of cattle under field condition maintained on various managements

According to the status of maintenance of cattle, it was divided into four groups (groups A, B, C and D) and the haematological and biochemical values were presented in table 4 and table 8 .

4.3.2.1 Haemoglobin

From the table 4, it was seen that the mean values of haemoglobin percentage of gr. A (Stall feeding), gr. B (Stall feeding with concentrate), gr. C (grazing with concentrate) and gr. D (grazing only) were 13.24 ± 0.24 g%, 13.80 ± 0.31 g%, 13.86 ± 0.36 g% and 11.78 ± 0.35 g% respectively.

Statistical analysis revealed that the haemoglobin percentage in gr. D (grazing only) animals was significantly lower ($P < 0.01$) than that of gr. B (Stall feeding with

Table 3 : Haematological status of control animals

No. of animals	Hb g%	PCV %	TEC 10^6/Cmm	TLC 10^3/Cmm	DLC				
					N %	E%	B%	L%	M%
10	14.10 ±0.41	39.42 ±0.44	8.34 ±0.07	8.27 ±0.08	30.29 ±0.25	3.20 ±0.08	0.05 ±0.01	62.62 ±0.25	3.68 ±0.24

concentrate)and gr. C (grazing with concentrate) but there was no significant difference with gr. A (Stall feeding).

From the result, it was evident that the cattle which were maintained only on grazing suffer from low haemoglobin percentage as the grazing specially in tropical countries can rarely satisfy all mineral requirements (McDowell et al. 1983).

4.3.2.2 Packed cell volume

PCV value was 37.03 ± 0.31%, 38.78 ± 0.54%, 39.60 ± 0.63% and 31.70 ± 0.91% of gr. A, gr.B, gr.C and gr.D animals respectively. The value of gr.D animals was significantly lower (P < 0.01) in comparison to other three groups.

4.3.2.3 Total Erythrocytic Count (TEC)

Total erythrocytic count of the animals of gr. A, gr.B, and gr.C were 7.68 ± 0.15 millions/Cmm, 7.56 ± 0.33 million/Cmm, and 7.72 ± 0.31 millions/Cmm respectively. Statistical analysis revealed that there was insignificant difference among the three groups i.e. gr. A, gr. B and gr.C . However, the animals of gr. D (6.47 ± 0.17 millions/Cmm) showed significant difference (P < 0.01) when compared to other three groups.

4.3.2.4 Total Leucocytic Count (TLC)

The animals of gr.A, gr. B, gr. C and gr. D had the TLC value of 8.09 ± 0.09 thousand/Cmm, 8.02 ± 0.10 thousand/

Table 4 Haematological status of cattle
(Gr. A, Gr. B, Gr. C, & Gr. D)

GROUPS	Hb g%	PCV %	TEC 10^6/Cmm	TLC 10^3/Cmm	DLC				
					N%	E%	B%	L%	M%
Stall feeding (31) Gr. A	13.24^{ab} ±0.24	37.03^{a} ±0.31	7.88^{a} ±0.15	8.09^{a} ±0.09	29.31^{a} ±0.19	2.96^{a} ±0.05	0.05^{a} ±0.01	64.30^{a} ±0.23	3.25^{a} ±0.21
Stall feeding with concentrate (14) Gr. B	13.80^{a} ±0.31	38.78^{a} ±0.54	7.56^{a} ±0.54	8.02^{a} ±0.10	29.73^{a} ±0.26	2.97^{a} ±0.06	0.05^{a} ±0.01	63.82^{a} ±0.15	3.42^{a} ±0.22
Grazing with concentrate (10) Gr. C	13.86^{a} ±0.36	39.60^{a} ±0.63	7.72^{a} ±0.31	8.04^{a} ±0.14	29.14^{a} ±0.42	3.06^{a} ±0.07	0.02^{a} ±0.02	64.29^{a} ±0.21	3.13^{a} ±0.17
Grazing only (10) Gr. D	11.78^{b} ±0.35	31.70^{b} ±0.91	6.47^{b} ±0.17	8.18^{a} ±0.07	30.37^{a} ±0.18	3.20^{a} ±0.06	0.01^{a} ±0.01	63.53^{a} ±0.24	3.12^{a} ±0.11

Values within a column followed by a common letter are not significantly different (P ≥0.01).

Cmm, 8.04 ± 0.14 thousand/Cmm and 6.18 ± 0.07 thousand /Cmm respectively. Statistical analysis showed that there was no significant difference within these 4 groups.

4.3.2.5 Differential Leucocytic Count (DLC)

The differential leucocytic counts of gr.A, gr. B, gr. C and gr. D were neutrophils (29.31 ± 0.19%, 29.73 ± 0.26%, 29.14 ± 0.42% and 30.37 ± 0.18% respectively) ; lymphocytes (64.30 ± 0.23%, 63.82 ± 0.15%, 64.29 ± 0.21% and 63.53 ± 0.24% respectively) eosinophil (2.96 ± 0.05%, 2.97 ± 0.06%, 3.06 ± 0.07%, and 3.20 ± 0.08%) basophil (0.05 ± 0.01%, 0.05 ± 0.01%, 0.02 ± 0.02% and 0.01 ± 0.01%) and monocyte (3.25 ± 0.2%, 3.42 ± 0.22%, 3.13 ± 0.17% and 3.12 ± 0.11%) respectively.

Literature on the haematological values of cattle under field condition maintained on various status were untraceable. However, undernutrition is commonly accepted to be the most important limitation to herbivore livestock production in tropical countries (McDowell et al., 1983). Cobalt and copper deficiencies result in nutritional anaemia or salt-sick have been reported under natural grazing conditions in many countries of the world (Fick et al., 1979).

4.3.3 Clinical manifestation of cattle under field condition

The cattle reared in the villages of Bagnabard, Barisha, Jalchak, Narangadighi and Naya of Midnapore district of

West Bengal were clinically examined for the evidence of anaemia, diarrhoea, anorexia, stunted growth, loss of milk yield, rough body coat, delayed oestrus, anoestrus, repeat breeding etc.

The clinical symptoms recorded in cattle reared under field management were of varied nature and the symptoms observed in general, supported the reports of Underwood (1977), McDowell *et al.* (1982), Miles and McDowell (1983) and Tejada *et al.* (1985).

4.3.4 Examination of faecal samples

The faecal samples of clinically ill cattle were examined for detection of parasites.

4.3.5 Prevalence

The results of the prevalence of various groups of cattle were presented in table 5 which indicated that out of 110 cattle examined, 65 (59.09%) were clinically ill. Of these 11 (gr. I) had anaemia with parasitism (16.94%), 13 (gr. II) cattle were having negative for parasitic infection and were supposed to be suffering from nutritional anaemia, (20.02%), 4 (gr. III) were anoestrus with reproductive disorder (6.16%), 15 (gr. IV) were anoestrus without reproductive disorders (23.10%), 8 (gr. V) were of non specific syndrome and 14 (gr. VI) were repeat-breeding animals (21.46%). Anoestrus without reproductive disorder were supposed to be

Table 5 Distribution of abnormalities of cattle

Area	No. of animals examined	No. of animals clinically ill	Anaemia with parasitism	Anaemia without parasitism	Non-specific syndrome	Anoestrus with reproductive disease	Anoestrus without reproductive disorders	Repeat breeding
Bagnabard	35	14	3	2	2	1	4	5
Barisha	20	7	1	2	1	1	1	1
Jalchak	10	7	0	1	1	0	2	0
Narangadighi	30	29	6	5	3	1	6	7
Naya	15	8	1	3	1	1	2	1
TOTAL	110	65	11	13	8	4	15	14

Table 6 Haematological status of cattle
(Gr.I, Gr.II, Gr.III, Gr.IV, Gr.V, Gr.VI)

GROUPS	Hb g%	PCV %	TEC 10^6/Cmm	TLC 10^3/Cmm	DLC				
					N%	E%	B%	L%	M%
Anaemia with parasitism (11) Gr. I	9.46^b ±0.26	26.41^c ±0.42	5.21^b ±0.21	8.81^a ±0.08	31.02^a ±0.32	3.48^a ±0.16	0.01^a ±0.01	62.93^a ±0.24	2.56^a ±0.21
Anaemia without parasitism (13) Gr. II	10.62^b ±0.28	29.46^c ±0.41	5.68^{ab} ±0.24	8.84^a ±0.10	30.82^a ±0.19	3.42^a ±0.13	0.02^a ±0.01	62.62^a ±0.25	3.12^a ±0.23
Anoestrus with reproductive disorders (4) Gr.III	14.12^a ±0.32	40.02^a ±0.62	7.82^a ±0.32	8.32^a ±0.22	31.46^a ±0.28	3.42^a ±0.15	0.05^a ±0.01	61.55^a ±0.24	3.52^a ±0.21
Anoestrus without reproduction disorders (15) Gr. IV	12.42^a ±0.34	35.46^b ±0.39	6.84^{ab} ±0.21	8.44^a ±0.14	30.42^a ±0.16	3.92^a ±0.12	0.05^a ±0.02	61.93^a ±0.12	3.68^a ±0.21
Non-specific disease syndrome (8) Gr. V	13.62^a ±0.31	38.26^{ab} ±0.42	7.16^a ±0.31	8.01^a ±0.06	31.62^a ±0.24	3.16^a ±0.12	0.08^a ±0.05	61.32^a ±0.27	3.82^a ±0.24
Repeat breeding (14) Gr. VI	13.72^a ±0.30	38.28^{ab} ±0.41	7.18^{ab} ±0.32	8.02^a ±0.12	30.82^a ±0.26	3.92^a ±0.13	0.02^a ±0.01	62.12^a ±0.25	3.12^a ±0.23

presented in table 3 .

4.4.2 Haemoglobin

The healthy control animals showed 14.10 ± 0.41 g% Hb. The Hb value of groups - I, II, III, IV, V and VI was 9.46 ± 0.26 10.62 ± 0.26, 14.12 ± 0.32, 12.42 ± 0.34, 13.62 ± 0.31 and 13.72 ± 0.30 g% respectively. Though the values differ numerically between gr. I and II but there is no significant difference. But the value of gr. I and gr. II differ significantly ($P < 0.01$) from gr. III, IV, V and VI.

Sawhney et al. (1974) also recorded more than 50% of the animals with low Hb%. Chillar et al. (1979) further observed that about 60% of the livestock had low Hb content in Taral area of the district of Nainital, Pilibhit and Lakhimpur, Uttar Pradesh.

4.4.3 Packed Cell Volume (PCV)

The present study indicated low level of PCV in parasitic anaemia gr. (Group - I) under field condition. The value was 26.41 ± 0.42% when compare to control healthy group (39.42 ± 0.44%).

The value of Groups- I, II, III, IV, V and VI was 26.41 ± 0.42%, 29.46 ± 0.41%, 40.02 ± 0.62%, 35.46 ± 0.39%, 38.26 ± 0.42% and 38.28 ± 0.41% respectively. The results clearly indicated that there was no significant difference

between Group - I and II but both the value differ significantly (P < 0.01) from other four groups of animals.

The present findings simulated with the reports of Sawhney et al. (1974) and Chillar et al. (1979).

4.4.4 Total Erythrocytic Count (TEC)

The value of Groups - I, II, III, IV, V and VI was 5.21 ± 0.21, 5.68 ± 0.24, 7.82 ± 0.32, 6.84 ± 0.21, 7.16 ± 0.31 and 7.18 ± 0.32 million/Cmm respectively which clearly indicated that there was no significant difference between Group - I and II but there was a statistical difference when these groups- I and II compared with the groups III, IV, V and VI.

The present reports coroborated with the findings of Sawhney et al. (1974) and Chillar et al. (1979).

4.4.5 Total Leucocytic Count (TLC)

The present findings of TLC of all groups revealed normal range with the control group. The value ranging from 8.01 ± 0.06 to 8.84 ± 0.10 thousand/Cmm in Group - I, II, III, IV, V and VI. There was no statistical difference among the six groups.

The results are in accordance with the findings of Sawhney et al. (1974), Chillar et al. (1979) and Sarkar et al. (1990).

4.4.6 Differential Leucocytic Count (DLC)

In Groups - I, II, III, IV, V and VI, neutrophil per-

centage ranging from 30.82 ± 0.26 to 31.62 ± 0.24, eosinophil % 3.16 ± 0.12 to 3.92 ± 0.13, basophil % 0.01 ± 0.01 to 0.08 ± 0.05, lymphocyte % 61.32 ± 0.27 to 62.93 ± 0.24 and monocyte % 2.56 ± 0.21 to 3.68 ± 0.21. There was no significant difference among the values of all groups.

4.5 Biochemical changes in cattle

The results of the analysis of biochemical profile of different groups were presented in table 8 and 9. The same for healthy control animals was presented in table 7 .

4.5.1 Estimation of blood glucose (BHL)

Blood glucose level among the Group – A, B, C, and D was 52.74 ± 0.32, 53.88 ± 0.42, 54.08 ± 0.88 and 49.61 ± 0.29 mg% which clearly indicated that the value of Group D was the least when compared to other groups. There was no statistical difference in the values of group B and C, but statistically significant ($P < 0.01$) with group A. There was statistical differ once in the value of group D to other three groups. The values of groups- I, II, III, IV, V and VI was 46.25 ± 0.42, 47.62 ± 0.46, 54.65 ± 0.76, 51.25 ± 0.74, 52.97 ± 0.75 and 51.21 ± 0.81 mg% which indicate that group I and II were having least value in comparison to other groups. It may be due to parasitism as well as the maintenance of the animals in deficient pasture. There was statistical significance in between the values of both group I and II with groups III, IV, V and VI.

Table 7 Biochemical status of control animals

No. of animals	BGL mg%	TSP gm%	SI µg%	SCu µg%	SMo µg%	SCo µg%	SMn µg%	SZn µg%
10	55.82 ±0.46	7.62 ±0.18	378.42 ±5.17	188.45 ±1.25	17.42 ±0.25	37.24 ±0.16	127.82 ±0.18	384.24 ±5.41

Table 8 Biochemical status of cattle
(Gr. A, Gr. B, Gr. C, & Gr. D)

GROUPS	BGL mg%	TSP gm%	SI µg%	SCu µg%	SCo µg%	SMo µg%	SMn µg%	SZn µg%
Stall feeding (31) Gr. A	52.74^{b} ±0.32	6.13^{b} ±0.02	497.77^{b} ±3.74	478.30^{b} ±4.12	11.48^{b} ±0.34	14.16^{b} ±0.22	132.67^{c} ±1.81	878.73^{c} ±3.91
Stall feeding with concentrate (14) Gr. B	53.88^{a} ±0.42	6.88^{a} ±0.05	510.35^{b} ±3.78	467.18^{b} ±3.84	13.62^{a} ±0.36	15.12^{ab} ±0.24	134.03^{c} ±1.84	1324.53^{a} ±5.62
Grazing with concentrate (10) Gr. C	54.08^{a} ±0.88	7.12^{a} ±0.12	567.50^{a} ±3.82	526.12^{a} ±4.41	14.42^{a} ±0.38	16.42^{a} ±0.28	193.32^{a} ±1.92	1013.70^{b} ±04.41
Grazing (10) Gr. D	49.61^{c} ±0.29	6.12^{b} ±0.11	442.12^{c} ±3.16	392.12^{c} ±3.16	10.42^{b} ±0.31	14.86^{b} ±0.18	152.46^{b} ±1.98	876.42^{c} ±3.86

Values within a column followed by a common letter are not significantly different (P $\underline{<}$0.01).

Table 9 Biochemical status of cattle
(Gr. I, Gr.II, Gr.III, Gr.IV, Gr.V, Gr.VI)

G R O U P S	BGL mg%	TSP gm%	SI µg%	SCu µg%	SCo µg%	SMo µg%	SMn µg%	SZn µg%
Anaemia with parasitism (11) Gr. I	46.25^{c} ±0.42	6.21^{c} ±0.11	415.08^{d} ±3.02	459.44^{a} ±3.12	9.46^{d} ±0.32	16.24^{a} ±0.21	140.73^{c} ±1.36	923.69^{c} ±3.86
Anaemia without parasitism (13) Gr. II	47.62^{c} ±0.46	6.22^{c} ±0.17	539.83^{a} ±3.42	287.99^{d} ±2.68	12.84^{b} ±0.36	14.26^{b} ±0.26	107.40^{e} ±1.31	1006.70^{b} ±4.32
Anoestrus with reproductive disorders (4) Gr.III	54.65^{a} ±0.76	7.14^{a} ±0.16	388.00^{e} ±3.12	344.82^{c} ±2.92	10.48^{cd} ±0.31	17.14^{a} ±0.24	81.64^{d} ±1.91	415.42^{e} ±3.40
Anoestrus without reproductive disorders (15) Gr. IV	51.25^{b} ±0.74	6.81^{b} ±0.11	476.76^{c} ±3.42	271.43^{d} ±3.42	11.12^{c} ±0.34	16.42^{a} ±0.24	131.69^{b} ±1.30	353.75^{e} ±3.81
Non-specific disease syndrome (8) Gr.V	52.97^{b} ±0.75	6.69^{b} ±0.07	508.16^{b} ±3.41	460.23^{a} ±3.12	13.26^{ab} ±0.35	15.41^{ab} ±0.21	155.62^{a} ±1.32	1110.84^{a} ±3.69
Repeat breeding (14) Gr. VI	51.21^{b} ±0.81	6.77^{b} ±0.16	452.78^{c} ±3.12	386.48^{b} ±3.02	14.12^{a} ±0.38	16.48^{a} ±0.26	131.18^{b} ±1.32	626.96^{d} ±3.41

Values within a column followed by a common letter are not significantly different (P $\underline{<}$ 0.01).

There was also significant difference between the group - III with groups IV, V and VI.

The hypoglycaemic findings in parasitized anaemic cattle (gr. I) were similar with the reports of Ansari *et al.* (1978), Bizubic *et al.*, (1981) and Abbot *et al.*, (1984) in parasitic anaemia of cattle and lambs. A proper amount of host dietary carbohydrate is always needed for the normal development and growth of the worms. (Nadakal and Nair, 1979). Therefore, in addition to the impairement in the carbohydrate digestion of the host (Read and Simons, 1963), the parasites possibly consumed a greater quantity of carbohydrate leading to significant fall of blood glucose level in parasitized cattle. The hypoplycaemia in other groups was possibly due to inappetance or anorexia that might be due deficiency of cobalt in their feed. The reports of the present study were coroborated with the reports of Sarkar *et al.* (1990).

4.5.2 Estimation of total serum protein(TSP)

The value of group A and B (6.13 ± 0.02 and 6.12 ± 0.11 gm% respectively) significantly differ from the group - B and C (6.88 ± 0.05 and 7.12 ± 0.12 gm% respectively). The value of groups- I, II, III, IV, V and VI were 6.21 ± 0.11, 6.22 ± 0.17, 7.14 ± 0.16, 6.81 ± 0.11, 6.89 ± 0.07 and 6.77 ± 0.16 gm% respectively. From these results, it was clear that the value of group - I and II were less than the other groups. There was significant difference in the value of group I and II

with other four groups. Group - III was also statistically significant to other five groups and also group IV, V and VI to other three groups ($P < 0.01$).

The findings did not simulated with the reports of Borah et al. (1983) who observed no significant change in TSP values of goats infected with Strongyloides papillosus.

Depletion of serum protein level suggests that the infected cattle probably tried to compensate the loss of blood glucose level by the process of catabolising protein and concomitant gluconeogenesis. In addition to these, malabsorption and loss of bodyfluid might have been the another possible factor for hypoproteinaemia because one molecule of protein holds three molecules of water. Hypoproteinaemia was also observed in microdeficient cattle of other groups, possibly due to malnutrition resulting from low intake of energy and protein.

4.5.3 Estimation of serum iron (SI)

The SI content of all the groups were found to be more than control group. The value of groups A, B, C and D was 497.77 ± 3.74, 510.35 ± 3.78, 567.50 ± 3.82 and 442.1 ± 3.16 µg% respectively. The results indicated that the value of group D was the lowest and significant difference from other three groups. There was no significant difference in the value of group A and B but both varied significantly from other two groups (gr. C and gr. D).

The values of groups I, II, III, IV, V and VI was 415.08 ± 3.02, 539.83 ± 3.42, 388.00 ± 3.12, 476.76 ± 3.42, 508.16 ± 3.41 and 452.78 ± 3.12 µg% respectively. There was no significant difference in the value of group V and VI. However, there were significant difference among the rest of all the groups.

4.5.4 Estimation of serum copper (SCu)

The SCu content of the groups A, B, C and D was 478.30 ± 4.12, 467.18 ± 3.84, 526.12 ± 4.41 and 392.12 ± 3.16 µg% to compare the control healthy groups (188.45 ± 1.25 µg%) indicating that there was no significant difference between the group A and B but statistical significance was observed when compared with other two groups (group C and group D). Group D varied significantly ($P < 0.01$) from other three groups.

The value of groups I, II, III, IV, V and VI was 459.44 ± 3.12, 287.99 ± 2.68, 344.82 ± 2.92, 271.43 ± 3.42, 460.23 ± 3.12 and 386.48 ± 3.02 µg% respectively. The results clearly indicated that the value of group II and IV has no significant difference but all the values of other groups have significant difference to each other ($P < 0.01$).

4.5.5 Estimation of serum molybdenum (SMo)

The values of all groups having normal range when compared to healthy group. The value of group A, B, C and D

was 14.16 ± 0.22, 15.12 ± 0.24, 16.42 ± 0.28 and 14.96 ± 0.18 µg% when compared to healthy group (17.42 ± 0.25 µg%). There was no significant difference in the values of group A and D but significant difference was recorded between the other two group C and D.

There was no significant difference in the values of groupsI, III, IV, V and VI. But significantly differ in the values of group - II to other five groups. The Mo level showed normal indicating no interaction with the copper content.

4.5.6 Estimation of serum cobalt (SCo)

The values of all groups indicated that there was severe deficiency of SCo in animals when compared to healthy control group. The values of groupsA, B, C and D was 11.48 ± 0.34, 13.62 ± 0.36, 14.42 ± 0.38 and 10.42 ± 0.31 µg% when compared to control group (37.24 ± 0.16 µg%). There was no statistical significance in the values of group B and C and also in the groups A and D. But significant difference was observed between the values of group B and C with group A and D.

The values of six groups showed also severe deficiency of SCo. The value of six groups - I, II, III, IV, V and VI was 9.46 ± 0.32, 12.84 ± 0.36, 10.48 ± 0.31, 11.12 ± 0.34, 13.26 ± 0.35 and 14.12 ± 0.38 µg% respectively indicating no significant difference in the values of all the groups.

According to Underwood (1977) and Hansward (1983) young growing animals were the most sensitive to cobalt deficiency; next were mature sheep, calves and cows in that order. McDowell et al. (1983 and 1984) reported that cobalt deficiency occurs in large areas of many countries and is largely, but not exclusively restricted to grazing ruminants which have little or no access to concentrates. With the exception of Cu, Co deficiency is the most severe mineral limitation to grazing livestock in tropical countries. Visual manifestation of cobalt deficiency were not specific and similar to those found in malnutrition due to low intake of energy and protein. Animals on cobalt deficient pastures gradually showed loss of appetite, failure of growth or loss of weight followed by extreme loss of appetite, rapid muscular wasting, depraved appetite, severe anaemia and death. In case of mild or marginal deficiency the above clinical signs might never occur and only the most susceptible animals could exhibit with signs of unthriftiness, indistinguishable from the effects of parasitism or low feed intake. Milk forms of cobalt deficiency in grazing ruminants were difficult to diagnose on the basis of clinical and pathological signs because only the indications might be symptoms of unthriftiness without anaemia. Cobalt deficiencies on borderline states are extremely common and are characterised by low production rates, unaccompanied by clinical manifestations of visible signs, thereby resulting in great economic loss to the ruminant livestock industry. Co deficient animals respond quickly to Co treatment restoring appetite vigour and

Cobalt is dietary essential for ruminants and is needed in the bacterial synthesis of vitamin-B_{12} in the rumen. The vit. B_{12} a redish compound possessing Co containing tetrapyrolic ring which is required for maturation of RBC. Cobalt deficiency interferes the synthesis of DNA and cell replication through its precursor thymidylic acid (Schilling, 1953). In the present study, cobalt deficiency in the diet might be the cause of low level of Fe, and Cu in serum in experimental nutritional anaemia and anoestrus cattle in comparison to healthy control cattle, although the natural feed stuffs contained the required amount of iron. Movsum-Zade (1976) concluded that for healing and preventing hypocobaltosis, it is essential to use not only cobalt but also iron, copper and a preparation of protein and vitamin.

This low level of Co is possibly the contributing factor causing anoestrus and higher percentage of repeat breeding condition in cattle of Midnapore district.

4.5.7 Estimation of serum manganese (SMn)

The values of all the groups indicated slight variation from normal level of control group. The values of groupsA, B, C and D was 132.67 ± 1.81, 134.03 ± 1.84, 193.32 ± 1.92 and 152.4f ± 1.98 µg% in comparison with the value of control group (127.82 ± 0.18 µg%). There was no significant difference in the values of Group A and B. However, there was difference with other groups.

The values of groups- I, II, III, IV, V and VI were also of normal range and value was 140.73 ± 1.36, 107.40 ± 1.31,

Table 10 Haematological changes after treatment
(Gr. A, Gr. B, Gr. C and Gr. D)

GROUPS	BEFORE TREATMENT			AFTER TREATMENT					
	0 day			15 days			30 days		
	Hb g%	PCV %	TEC 10^6/Cmm	Hb g%	PCV %	TEC 10^6/Cmm	Hb g%	PCV %	TEC 10^6/Cmm
Stall feeding (31) Gr. A	13.24 ±0.24	37.03 ±0.31	7.88 ±0.15	13.92 ±0.31	37.84 ±0.32	8.01 ±0.14	14.76* ±0.32	39.84* ±1.12	8.16* ±0.26
Stall feeding with concentrate (14) Gr. B	13.80 ±0.31	38.78 ±0.54	7.56 ±0.33	14.12 ±0.26	39.01 ±0.26	8.12 ±0.32	15.26** ±0.35	40.16* ±1.01	8.24* ±0.31
Grazing with concentrate (10) Gr. C	13.86 ±0.36	39.60 ±0.63	7.72 ±0.31	14.10 ±0.32	39.24 ±0.62	7.84 ±0.29	14.86* ±0.31	40.08* ±1.13	8.15* ±0.26
Grazing only (10) Gr. D	11.78 ±0.35	31.70 ±0.91	6.47 ±0.17	13.90* ±0.35	36.41** ±0.81	7.46* ±0.18	14.84** ±0.34	39.68** ±1.06	8.10** ±0.32

* Significant at 5% level (P < 0.05)

** Significant at 1% level (P < 0.01)

significant, except gr. D. The value increased from 37.03 ± 0.31%, 38.78 ± 0.54%, 39.6 ± 0.63% and 31.70 ± 0.91% to 37.84 ± 0.32%, 39.01 ± 0.26%, 39.24 ± 0.62% and 38.41 ± 0.81% respectively.

Further estimation after one month treatment recorded significant rise. The values increased to 39.84 ± 1.12%, 40.16 ± 1.01%, 40.08 ± 1.13% and 39.68 ± 1.06% of gr. A, B, C and D respectively.

4.6.3 Total Erythrocytic Count

TEC value also increased to 8.01 ± 0.14 million/Cmm, 8.12 ± 0.32 million/ Cmm, 7.84 ± 0.29 million/Cmm, and 7.46 ± 0.18 million/Cmm from the pretreatment value 7.88 ± 0.15 million/Cmm, 7.56 ± 0.33 million/Cmm, 7.72 ± 0.31 million/Cmm, and 6.47 ± 0.17 million/Cmm of gr. A, B, C and D respectively after 15 days of treatment. Statistical analysis showed significant ($P < 0.05$) improvement in gr. D only.

The value of all the four groups significantly increased ($P < 0.05$) after one month of treatment to 8.16 ± 0.26 million/Cmm, 8.24 ± 0.31 million/Cmm, 8.15 ± 0.26 million/ Cmm and 8.10 ± 0.32 million/Cmm of gr. A, B, C and D respectively.

Literatures on the systematic supplementation with trace minerals in animals according to the status of micronutrients in soil and plant under field conditions are very

scarce. However, Sarkar et al. (1990) observed significant improvement in respect to haematology in goats (based mainly on grazing only) after supplementation of the trace minerals.

4.7 Treatment given to the animals of groups - I, II, III, IV, V and VI

There was gradual improvement by treatment in clinically ill cattle of all six groups i.e. gr. I anaemia with parasitism, gr. II anaemia without parasitism, gr. III anoestrus with reproductive disorders gr. IV anoestrus without reproductive disorders, gr. V non-specific disease syndrome and gr. VI repeat breeding cattle. The values were given in the table ii.

4.7.1 Haemoglobin

The value of Hb% increased significantly ($P < 0.01$) both anaemic groups (gr. I and II) after 15 days of treatment from 9.46 ± 0.26 g% and 10.62 ± 0.28 g% to 12.41 ± 0.30 g% and 12.12 ± 0.29 g% respectively. Finally, the value increased significantly ($P < 0.01$) after one month treatment to 15.21 ± 0.26 g% and 14.86 ± 0.30 g% respectively.

The value of gr. II and IV increased to 14.84 ± 0.28 g% and 14.01 ± 0.28 g% from pre-treatment value 14.12 ± 0.32 g% and 12.42 ± 0.34 g% respectively, after 15 days of treatment.

The value of gr. III increased non-significantly but increased significantly ($P < 0.05$) the value of gr. IV .

Table 11 Haematological changes after treatment
(Gr.I, Gr.II, Gr.III, Gr.IV, Gr.V and Gr.VI)

GROUPS	BEFORE TREATMENT			AFTER TREATMENT					
	0 day			15 days			30 days		
	Hb g%	PCV %	TEC 10^6/Cmm	Hb g%	PCV %	TEC 10^6/Cmm	Hb g%	PCV %	TEC 10^6/Cmm
Anaemia with parasitism(12)Gr.I	9.46 ±0.26	26.41 ±0.42	5.21 ±0.21	12.41** ±0.30	35.10** ±0.31	7.41** ±0.10	15.21** ±0.26	40.01** ±1.10	8.65** ±0.21
Anaemia without parasitism(13)Gr.II	10.62 ±0.28	29.46 ±0.41	5.68 ±0.24	12.12 ±0.29	34.80** ±0.42	7.01** ±0.14	14.86** ±0.30	39.16** ±1.12	8.16** ±0.20
Anoestrus with reproductive disorders(4)Gr.III	14.12 ±0.32	40.02 ±0.62	7.82 ±0.32	13.84 ±0.28	40.01 ±0.36	7.16 ±0.09	15.01* ±0.31	39.82 ±1.24	8.68* ±0.26
Anoestrus without reproductive disorders(15)Gr.IV	12.42 ±0.34	35.40 ±0.39	6.84 ±0.21	14.01* ±0.28	39.46** ±0.61	7.82* ±0.07	14.80** ±0.28	39.12** ±1.12	8.76** ±0.00
Non-specific disease syndrome (8) Gr. V	13.62 ±0.31	38.26 ±0.42	7.16 ±0.31	14.12 ±0.31	40.02 ±0.46	7.46* ±0.11	14.82* ±0.29	40.00* ±1.06	8.04* ±0.27
Reapet breeding (14) Gr. VI	13.72 ±0.30	38.28 ±0.41	7.18 ±0.32	14.32 ±0.31	39.12 ±0.36	7.67 ±0.10	15.00** ±0.31	39.22 ±1.01	8.12 ±0.19

* Significant at 5% level (P < 0.05)

** Significant at 1% level (P < 0.01).

The value increased significantly (P $\lesssim$ 0.01) after one month of treatment to 15.01 $\pm$ 0.31 and 14.80 $\pm$ 0.28 g%.

The value of gr. V increased but not significantly (P $\lesssim$ 0.05) from 13.62 $\pm$ 0.31 g% to 14.12 $\pm$ 0.31 g% after 15 days of treatment and finally increased significantly after one month treatment to 14.82 $\pm$ 0.29 g%.

The value of gr. VI increased from 13.72 $\pm$ 0.30 to 14.32 $\pm$ 0.31 after 15 days of treatment and finally increased significantly (P $\lesssim$ 0.01) to 15.00 $\pm$ 0.31 after 30 days of treatment.

4.7.2 Packed Cell Volume

The value of PCV% of anaemic gr. I and gr. II increased significantly (P $\lesssim$ 0.01) to 35.10 $\pm$ 0.31% and 34.80 $\pm$ 0.42% from pre-treatment value 26.41 $\pm$ 0.42% and 29.46 $\pm$ 0.41% after 15 days of treatment respectively.

After treatment of one month both values increased significantly (P $\lesssim$ 0.01) to 40.01 $\pm$ 1.10% and 39.16 $\pm$ 1.12%.

In anoestrus groups (III and IV), PCV% also increased to 40.01 $\pm$ 0.36% and 39.46 $\pm$ 0.61% from pre-treatment value 40.02 $\pm$ 0.62% and 35.46 $\pm$ 0.39% after 15 days of treatment. The value increased significantly (P $\lesssim$ 0.01) in the gr. IV but not in gr. III.

After one month of treatment, the PCV value also increased to 39.82 $\pm$ 1.24% and 39.12 $\pm$ 1.12%.

The value of gr. V also increased from 38.20 ± 0.42% to 40.02 ± 0.46% significantly (P < 0.05) after 15 days treatment and finally to 40.00 ± 1.00% after one month of treatment.

The value of gr. VI increased to 39.12 ± 0.36% from 38.28 ± 0.41% after 15 days of treatment but statistically non-significant. Finally the value increased to 39.22 ± 1.01% after one month of treatment.

4.7.3 Total Erythrocytic Count

The value of gr. I and II (Parasitic anaemia and nutritional anaemia grs) significantly increased (P < 0.01) to 7.41 ± 0.10 million/Cmm and 7.01 ± 0.14 million/Cmm from pre-treatment value 5.21 ± 0.21 million/Cmm and 5.68 ± 0.24 million/Cmm respectively. The value of both the groups finally increased significantly (P < 0.01) to 8.65 ± 0.21 million/Cmm and 8.16 ± 0.20 million/Cmm respectively.

There was gradual improvement in the value of gr. III and IV (anoestrus with reproductive disorders and anoestrus without reproductive disorders) after 15 days of treatment which was recorded as 7.16 ± 0.09 million/Cmm and 7.82 ± 0.07 million/Cmm from 7.82 ± 0.32 million/Cmm and 6.84 ± 0.21 million/Cmm pre-treatment value. The improvement to the value of gr. IV was statistically significant (P < 0.05) only.

The value of non-specific group (gr. V) also incr-

eased to 7.40 ± 0.11 million/Cmm from pre-treatment value 7.16 ± 0.31 million/Cmm after 15 days of treatment but increment was not statistically significant. The value increased after one month to 8.04 ± 0.27 million/Cmm which was statistically significant (P /0.01).

The value of gr. VI (repeat breeding) improved from pre-treatment value 7.18 ± 0.32 million/Cmm to 7.67 ± 0.10 million/Cmm but not significantly after 15 days of treatment. The value increased significantly (P /0.01) after one month treatment.

Gr. I animals (anaemia with parasitism) and gr. II (anaemia without parasitism) animals showed positive response to treatment and all the animals were cured from anaemic condition, which coroborated with the findings of Sarkar (1989).

There was improvement of haematological profile of gr. III (anoestrus with reproductive disorders) animals. However, the animals did not show any sign of oestrus. From this findings, it was indicating that the animals were suffering from other than the nutritional factors.

In case of gr. IV (anoestrus without reproductive disorders) animals, the haematological status improved significantly. Out of 15 animals 8 animals (53.33 %) showed sign of oestrus and subsiquently conceived.

Anoestrus due to nutritional origin recovered with

mineral supplementation was reported by Hafez (1973), Johari, M.P. and Talapatra, S.K. (1957).

In case of gr. V (non-specific disease syndrome), status of animals improved apparently with supplementation of the trace minerals.

In case of gr. VI (repeat breeding) animals, all the animals, were treated with intrauterine infusion of antibiotics (Luktuke et al., 1959) before supplementation. Out of 14 animals 7 (50%) showed gradual improvement of haematological status and subsequently conceived.

Repeat breeding condition (nutritional origin) corrected with supplementation was also reported by Tomar (1984).

CHAPTER V

SUMMARY AND CONCLUSION

The analysis of soils and plants in relation to micro-elements of the cattle in some villages of Midnapore district West Bengal was under taken to ascertain mineral deficiencies, imbalances and toxicities as it is responsible for low productivity.

Trace minerals status of soil in grating field of Midnapore district :

The pH of the soil samples of the grazing area of animals varied between 7.33 to 10.90 (average 8.15). The majority of the soil samples from different areas of the grazing field revealed alkaline pH.

Fe, Cu, Mo, Co, Mn and Zn contents of the soils were found to be in the range of 218.24 $\pm$ 1.11 ppm to 742.56 $\pm$ 3.22 ppm (average 405.79 $\pm$ 1.81 ppm), 1.85 $\pm$ 0.08 to 4.28 $\pm$ 0.23 ppm (average 3.45 $\pm$ 0.27 ppm), 2.76 $\pm$ 0.22 to 5.92 $\pm$ 0.36 ppm (average 4.25 $\pm$ 0.25 ppm), 0.26 $\pm$ 0.11 to 3.92 $\pm$ 0.62 ppm (average 2.28 $\pm$ 0.35 ppm), 31.86 $\pm$ 1.12 to 45.20 $\pm$ 1.62 (average 42.83 $\pm$ 1.66 ppm) and 0.89 $\pm$ 0.02 to 3.58 $\pm$ 0.12 ppm (average 1.68 $\pm$ 0.25 ppm) respectively.

The results of analysis of different soil samples in respect of microelements did not reveal any sign of dificiency except that of Cu and Co level. These two elements were low

in soils in comparison with the reports made by other soil scientists.

Trace minerals status of the plants of the grazing field

Fe, Cu, Mo, Co, Mn and Zn contents of different samples of grass of the grazing fields were 492.36 ± 2.26 to 3473.27 ± 5.62 ppm (average 999.34 ± 3.46 ppm), 13.40 ± 1.12 to 36.39 ± 1.62 ppm (average 25.29 ± 1.31 ppm), 0.84 ± 0.06 to 1.02 ± 0.21 ppm (average 0.93 ± 0.16 ppm), 0.04 ± 0.01 to 0.18 ± 0.02 ppm (average 0.093 ± 0.06 ppm), 49.99 ± 0.17 to 334.52 ± 0.23 ppm (average 121.63 ± 0.40 ppm) and 29.46 ± 0.41 to 81.19 ± 0.52 ppm (average 47.12 ± 0.32 ppm) respectively.

The analysis of different plant samples revealed that Fe, Cu, Mo, Co, Mn and Zn contents were 343.51 ± 1.62 to 3175.56 ± 5.62 ppm (average 1624.25 ± 2.95 ppm) ; 17.66 ± 0.28 to 34.48 ± 0.25 ppm (average 27.05 ± 0.93 ppm); 1.02 ± 0.28 to 3.01 ± 1.42 ppm (average 2.07 ± 1.26 ppm) ; 0.24 ±0.11 to 4.60 ± 1.64 ppm (average 1.45 ± 0.82 ppm) ; 53.57 ± 0.68 to 840.47 ± 1.22 ppm (average 235.41 ± 0.90 ppm) and 31.97 ± 0.42 to 85.26 ± 0.24 ppm (average 61.78 ± 0.33 ppm) respectively.

The Co content of grasses was very low (below the dietary recommendation). But it was evident that the bulk

of the pasture land contained the grasses (Cyanodon dactylon) and cattle fully depend on such grasses for their maintenance. So it clearly indicated that there was low level of cobalt in their feed. This low level of Co might be the possible factor for causing cobalt responsive anoestrus in cattle.

The other microelements in the grasses were normal but less than that of plant content.

The iron and zinc content of the plants were within the normal range which were above the dietary recommendation to prevent their difficiency in animals. Cu and Mo content was also found within the normal range. But there was very low level of Co content of plants which leads to defficiency syndrome in cattle.

Trace mineral status of cattle of grazing field of Midnapore district

Prevelance

The cattle of Midnapore district, West Bengal, from villages like Bagnabard, Barisha, Jalchak, Narangadighi and Naya were clinically examined. Based on the clinical manifestations out of the 110 cattle, 65 (59.09%) were clinically ill of these, 11 (16.94%) showed anaemia with parasitism, 13 (20.02%) showed nutritional anaemia (anaemia without parasitism), 8 (12.32%) showed non-specific disease syndrome like stunted growth, loss of milk production,

rough body coat, inappetance etc., 4 (6.16%) showed anoestrus with reproductive disorder, 15 (23.10%) showed anoestrus without reproductive disorders (supposed to be nutritional) and 14 (21.46%) showed repeat breeding condition.

Haematological changes

The level of Hb, PCV and TEC were marginally low to much low in comparison to the values of control animals. Anaemia with parasitism group of animals was having the least Hb% which was 9.46 ± 0.26 gm% in comparison to healthy control (14.10 ± 0.41 gm%). There was no significant difference in TLC and DLC of both control and clinically ill animals.

Biochemical changes

The results of analysis of BGL showed low value in clinically ill cattle than control group. Of these, anaemia with parasitism group of cattle showed least BGL (46.25 ± 0.42 mg%). However, TSP was marginally low to normal in all the groups. The iron, copper, manganese and zinc were within normal range in both healthy and clinically-ill animals. On the other hand, serum molybdenum level was within normal range but there was low level of cobalt in all clinically-ill animals, in comparison to healthy control cattle.

The investigation of present study can be summarised and the conclusions can be drawn as follows :

1. The trace elements status of soil of the grazing field of animals such as Fe, Cu, Mo, Co, Mn, and Zn were studied and the results did not show any sign of dificiency barring Co.

2. The grasses and plants grown on such soil contained enough Zn and Mn. Co content of the soil was dificient, it was observed that in grasses and plants the same is also deficient. The level of Mo did not cause concern of interaction with Cu. Co content of plants and grasses were marginal to low for grazing cattle.

3. While studing the prevalence of the disease in grazing cattle in some villages at Midnapore district, it was calculated that 59.09% was found to be clinically ill. Of these 16.94% anaemia due to parasitism, 20.02% anaemia due to nutrition, 5.16% anoestrus due to reproductive abnormalities, 23.10% anoestrus due to not reproductive disorders, 12.32% non-specific disease syndrome and 21.46% repeat breeding condition.

4. The haematological and bio-chemical profiles of diseased cattle were less than the values of control animals.

5. The low level of Co is possibly contributing

factor for causing anaemia, anoestrus and repeat breeding condition in grazing cattle of Midnapore district.

6. Considering the above observation, supplementation with trace minerals iron, copper and cobalt proved very effective in alleviating the syndrome of anaemia, anoestrus without reproductive disorders (53.33%) repeat breeding condition responded to treatment and conceived subsequently (50.00%).

CHAPTER VI

FUTURE SCOPE OF RESEARCH

CHAPTER VII

BIBLIOGRAPHY

BIBLIOGRAPHY

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