MINERAL IMBALANCES AND SUPPLEMENTATION STUDIES A TOOL TO AUGMENT PRODUCTION AND REPRODUCTION IN FARM ANIMALS

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In north - western Himalayan region sheep and Goat rearing by way of nomadic pastoralism has become a way of life since long. North West Himalayan region which mainly comprises of Himachal Pradesh, Jammu & Kashmir and part of Punjab, sheep are reared on range land by way of primary consumers of the vegetation formed by the capture of solar energy. In natural state these animals would in turn adapt spatially and in turn proper numbers for more or less sustained survival. However the human demand for off take of consumable products (food & fibre) imposes a requirement in excess of survival and so creates an equilibrium that is less than a natural balance. Restricted movement, altered numbers and controlled breeding imposes an unnatural match between what is offered by the vegetation and what is required by the grazing animal.

The basic nutrients required by animals are energy, protein, vitamins and minerals. The concept of requirement is generally seen as the amounts necessary to support “normal” metabolic activity. Animal’s requirements are thought to be met when it gives evidence of health and vigor, normal growth, production and reproduction.

Requirement of energy, protein and vitamins of sheep maintained on pasture is met by virtue of their adaptability to forage-based animal production system. As by virtue of evolution of pregastric fermentation chamber, ruminants can more effectively utilize carbohydrate (NDF) than either non-ruminants or post-gastric fermenters and further endogenous or simple dietry nitrogen (ammonia releasing compounds i.e. urea, protein, amino acids etc.) can be source of protein, as being due to microbial synthesis of protein which is digested in the gastric intestinal region.

However the requirement of minerals remains for from being complete due to the fact that generally pasture land are deficient in most of minerals, resulting in similar deficiency in grasses of those pastures. Water sources in pasture area are surface water/ice water, which lacks any minerals (table 1). Hence due to mineral deficiency in forage and water, its very likely to be reflected in form of mineral deficiency in range land ruminants thus resulting in production and reproduction losses.

Mineral Imbalances:

Mineral imbalances and deficiencies are quite common in sheep flock maintained in alpine pastures of Himachal Pradesh. Mostly mineral deficiency exist in flocks are non-clinical or sub-clinical, which affects fertility, growth rate and wool yield. Heavy parasitism and poor grassland quality further adds to the intensity of mineral deficiency.

Our studies on mineral status of forage, soil and water of alpine pastures of Kinnaur Distt. (H.P.) revealed that magnesium content in forages is low, where as certain elements are in excess of their requirement, thus acting as antagonist for other elements and thus causing mineral imbalance. Mineral imbalances may arise singly or in various combinations. Imbalances of major elements i.e. Ca, P, Mg, Na may cause rickets, lameness, milk fever, lambing sickness, tetany, reduced appetite,

while deficiency of trace elements i.e. Co, Cu, I, Mn, Se, Zn may cause ill thrift, abortion, placental retention, lambs deaths, reduced immunity in calves, infertility, susceptibility to bacteria and parasites and poor skin/hair/fleece quality.

Diagnosis of Mineral Imbalance:

Examination of blood and hair/wool of animal, forage and soil for mineral profile helps to identify the specific mineral imbalances. However before going for laboratory examination of blood, hair etc., flock and its living environ's should be thoroughly checked by veterinarian for diagnose and suggesting remedial measures.

Mineral stores in the body: Minerals can be classified into three types as regards effective stores and recycling in the body:

Good stores and recycling (Ca, P, Na, Cu, Se): These elements can be short in the diet for weeks or months without causing observable problems, provided that the body stores were "full" before the period of shortage. In that period, mobilisation from the stores helps to maintain normal levels in blood, body fluids of cells that need those minerals. If a period of plentiful supply of the element follows a period of shortage, the stores are replenished again. Thus, months of supplementation with Cu and Se indoors confers good protection for a period spent at pasture even if the supplements are removed while at pasture. As a rough guide, 1 month indoors on a high Cu or Se supplement before turnout confers about 1 month's cover after removal of the supplement at pasture.

Medium stores and recycling (I): Iodine (I) comes in category of medium stores, which give protection for only 2-3 weeks in periods of shortage. Thus, months of supplementation with I indoors may not maintain I status during the breeding period at pasture if I supplements are removed at range land to I-deficient pasture. In I-deficient groups, oral I doses are needed daily, but doses at 1-2 week intervals also are effective.

Poor stores and recycling (Mg, Co): Although bone and other body cells contain a lot of Mg, those stores are "locked", i.e. are not available for release in times of Mg shortage. Thus, provision of Mg supplement for weeks before the tetany risk period has little value, except to train the animals to take the supplement. Mg supplement is needed daily throughout the risk period. Co has no effective recycling in ruminants and no effective store exists in the body. Therefore, Co-deficient animals need Co supplement very frequently, preferably daily, although dosing at intervals of 14 days is effective in Co-deficient stock.

Mineral Supplementation:

Dosage and frequency of administration of veterinary products as mineral supplements depends on the weight of the animals, the degree of challenge to the mineral status and the chemical potency and form of the compound to be administered. Although general dose rates of veterinary products and their usage are suggested in the table 1, this may need alteration in specific cases. Farmers should consult local vets as regards the most applicable and economic methods for their flock. Heavier animals need larger doses. More frequent doses are needed in groups exposed to high challenge, such as on feeds that contain antagonists to the deficient mineral. Some products are short-acting; others are long-acting. Normal mineral status in animals usually can be ensured if

adequate mineral supplements are given. These are justified if the health history suggests clinical or sub-clinical signs of deficiency.

Mineralised concentrate rations: If mineral mixes are not fed, ensure that Co, Cu, I, Mn, Se and Zn (at least) are included in the concentrate feed or mineral mixture or salt.

Mineral mixes are best fed in the concentrate ration or sprinkled over easy-feed silage 2-3 times/d, or mixed with 3-4 times their weight of palatable carrier (say molassed beet pulp, or rolled barley 94% + molasses 6%). Reputable mineral preparations at the recommended doses should only be given.

Free-access systems (blocks, licks, loose minerals): Daily intake of minerals by free-access to blocks, licks and loose minerals in troughs is very variable between animals. *Free-access systems* (wet or dry licks, blocks, loose minerals in troughs etc) *are not as reliable as fixed-rate daily mineral supplementation*. This is especially so in winter, when fixed-rate mineral feeding is easy. Even at grass, fixed-rate mineral feeding in feed, palatable carrier, or water is more reliable than free-access systems. Fixed-rate feeding of supplements is much more reliable in preventing mineral/vitamin deficiency in small ruminants.

General methods of mineral supplementation: Mineral supplements may be given in many ways (oral supplements, water medication, veterinary products, foliar dusting or spraying or mineral application to soil). Whichever method is chosen, the correct dose or application rate is essential.

Effective oral trace element supplements for sheep

Oral supplements that provide less than the minimum daily allowance are unlikely to be effective. However, the upper levels were used widely without problems in recent years provided that no other supplements were used.

Table 1. European Community (EC) Regulation on Trace Elements in feed:

The EC (Additives in Feeding stuffs) (Amendment) regulation, 1991, S.I. No. 124 of 1991 gives the following as the maximum content of trace element in the complete feeding stuff for cattle and sheep, and the value converted to mg/kg DM, assuming a DM content of 88% in "complete feeds":

Element	Max level (mg/kg) permitted in complete feed	Max level (mg/kg DM) permitted (assuming 88% DM in "complete feed")
Cobalt (Co)	10	11.36
Copper (Cu)	15	17.05
	30	34.09
	50	56.82
	35	39.77
Iodine (I)	10	11.36
Manganese (Mn)	250	284.09
Selenium (Se)	0.50	0.57
Zinc (Zn)	250	284.09

Thus, the supplementation levels that we recommend for Co, I, Mn and Zn are well within the maxima permitted under current EC regulations, even at the lower DM intake (2% of Live Weight) and *the recommended supplementation levels for Se and Cu are just below the maxima permitted under current EC regulations at the lower DM intake (2% of LW), and are well below the maxima allowed at DM intakes of 3% of LW.*

Why apply trace elements to soil ?

The main reason for applying trace elements to soil is to try to raise the level of trace element in herbage, in an attempt to correct the economic effects of the deficiency in animals. However, soil application fails to control severe induced or secondary trace element deficiency in animals, such as that due to antagonists in the feed. Trace element fertilisation does not eliminate antagonists from the feed nor does it increase grass growth.

Soil application may be effective in simple deficiency of Co, Se and Cu.

In simple Co deficiency, where soil Co levels are low and soil Mn levels are normal (below 500 mg/kg), application of Co sulphate (2.24 kg/ha every 3-4 years) can raise herbage Co to normal levels. In simple Se deficiency, annual application of Na selenite (150 g/ha) can raise herbage Se to normal levels. Herbage Se levels above 3 mg/kg DM (the toxic level) can arise for some weeks after application. Serious over-application of Se salts can lead to Se toxicity in stock. [Only $1/8^{th}$ to $1/17^{th}$ of the soil applied-Se would be effective if given directly to stock as an oral supplement (12-24 mg Na selenite/cow/d X 365 d = 4.38-8.76 g/cow/year)].

In simple Cu deficiency, application of Cu sulphate (22 kg/ha) can increase herbage Cu to marginal or normal levels for 7-12 years after application. As Cu hydroxide is less subject to leaching, it may last longer than Cu sulphate on sandy soils. Though its not recommended for exclusive sheep pastures.

Precaution: To avoid the risk of accidental toxicity, allow time for the salts to be washed into the soil. Herbage regrowth should not be grazed for some weeks afterwards.

Periodic drenching with trace element supplements

Simple trace element drenches and anthelmintics with added trace elements: Simple trace element drenches can be made up by veterinary surgeons or chemists. They may contain Se, I, & Co , singly or in various combinations. Some commercial anthelmintic drenches also contain added trace elements, such as Co and Se. Such drenches can be used to prevent or control trace element deficiency, provided that they contain nutritionally effective levels of the required trace element(s) and are given at intervals of 2-3 weeks.

Formulation of a trace element drench for sheep: In practice, depending on the specific deficiencies identified on the farm, only 1-3 of the ingredients are used together and the unwanted ingredients are omitted from the formulation.

The following can be used:

17.5 g	Sodium selenite (30.0% Se)	=	5.25 g Se
61.0 g	Potassium iodide (76.4% I)	=	46.6 g I
100.0 g	Cobalt sulphate (21.0% Co)	=	21.0 g Co

413.4 g Copper sulphate (25.4% Cu) = 105.0 Cu

Add water to 15 litres. Shake until ingredients are fully dissolved.

** Omit Cu except on veterinary advice.

CONTROL OF SPECIFIC MINERAL IMBALANCES IN LIVESTOCK

i) Control of Sodium (Na) Deficiency in Sheep

Many silages and some herbages are low in Na, especially for lactating animals. The K/Na ratio in feed may exceed optimal values of 20/1 if Na is low, or if K is high. Na shortage may also restrict Mg absorption. The main methods of preventing Na shortage are to give Na supplements and to avoid excessive K intakes, especially by lactating females. Na chloride (common salt, 39% Na) is the most common Na salt. Avoidance of excessive use of K fertiliser helps to maintain more normal K/Na ratios in forage, especially on spring herbage. Na fertilisation of the soil (22% Na) at 0.5 tonnes/ ha may increase herbage Na levels.

Effective oral Na supplements: Large amounts of Na are stored in plasma and body fluids and are recycled very efficiently via saliva into the digestive tract for reabsorption. This recycling is useful in times of Na shortage. Thus, Na supplements need not be given daily, as long as adequate amounts are given over any given period of days or weeks. Na allowances depend on Na levels in the basic feed and on Na requirement for late pregnancy, production and reproduction. Animals with unrestricted access to clean water can handle large excesses of salt without difficulty. The best way to ensure normal Na status is to feed Na in the concentrate ration or to graze the animals on pasture with a good Na level. The cheapest method is to give an oral Na supplement: at rate of 1.0-2.3 g Na (2.6-5.9 g salt)/head/d in ewes, however they can handle up to 10 g Na (26 g salt) or more/d without problems.

ii) Control of Calcium (Ca) Imbalance, Hypocalcaemia and Milk Fever in Sheep and Goat

The main methods of routine prevention are: to control body condition at calving; to minimise Ca intake in late pregnancy; to ensure adequate Mg intake pre-calving; to minimise stress at calving; to optimise feed intake on the day of calving. If all else fails, give large doses of oral Ca +/- P supplement just before and after calving. Calcium carbonate (34% Ca) and di-calcium phosphate (22% Ca, 18% P) are common Ca salts.

iii) Control of Zinc, copper and iron imbalance in Sheep and Goat

Zn deficiency can be simple (low levels in soil and feed) or induced by high feed Ca levels, which block Zn absorption from the gut. Primary deficiency of Zn is rare in ruminants. Secondary deficiency, due to excess dietary Ca, can occur. Oral Zn is the main method of correction. Zn sulphate (22.7% Zn) is a common Zn salt. In our studies a significant increase in zinc concentration in blood plasma was recorded at high altitude, which may be attributed to high dietry zn intake through grasses. However plasma copper level declined, possibly due to high iron level, as its established fact that iron is antagonist to copper bioavailability in animal body. Reliable information is limited for the influence of absolute or conditional copper deficiencies on the fertility. Whereas due to abundance of iron in the most of feedstuff its deficiency is rarely reflected in blood. Co deficiency can be simple (low levels in soil and feed) or induced by high soil manganese (Mn), which prevents uptake

of Co by herbage. Oral Co is the main method of correction of Co deficiency. Co sulphate (21.0% Co) is a common Co salt. Co by injection has no value.

Effective oral Co supplements: Co has no effective recycling in ruminants and no effective store exists in the body. Therefore, Co-deficient animals need Co at very frequent intervals. Co can be given in the concentrate ration or forage, in a carrier or in mineral mixes. Oral Co is usually cheaper than Co-fertilisation.

Cu deficiency can be simple (low levels in soil and feed) or induced by high levels of Cu-antagonists in the diet (Mo, soil, Fe, factors in lush grass, S in sheep). Use of veterinary Cu products and oral Cu are the main method of correction of Cu deficiency. Cu sulphate (25.4% Cu) is a common Cu salt. One may use pasture management to reduce the intake of Cu-antagonists also. In simple Cu deficiency, soil application of Cu may be considered.

iv) Control of Iodine imbalance in Sheep and Goat

I deficiency can be simple (low levels in soil and feed) or induced by high levels of I-antagonists in the diet (goitrogens, factors in lush grass, high Ca intake). Oral I is the main method of correction of I deficiency. Potassium iodide (76.4% I) is a common I salt. In addition, reduce the intake of I-antagonists.

Tincture of I applied to the skin: 7 ml/cow/week of 5% tincture of I (or 14 ml of 2.5% tincture) painted or sprayed onto the thin skin of the pocket of the flank fold weekly for 5 weeks before calving or breeding in cows is a cheap, safe and effective I supplement.

Soil fertilisation with I: If I deficiency reduces animal performance, I supplements must be given directly to the animals. Soil application of I compounds may increase herbage I levels for a period after application. However, plant uptake of applied I is poor and I may be leached quickly from soil.