Minerals and Vitamins
Can they influence fleece quality?

By Jonathan Guy

The old adage of if something looks good on the outside then it must be thriving on the inside is still a very correct statement. Traditionally we have judged the performance of all animals by the visual condition of them, only in more recent times have we been able to monitor and judge performance on daily live weight gain.

For years the average sheep farmer in the UK has seen shearing as a necessary but expensive chore, with most looking at lamb production as the only income, however the tide is now turning after an extensive campaign for wool, with fleece prices seeing a great resurgence in recent years, reaching a 25 year high of 175p / kg in top quality flocks, Romneys will produce about £6 worth of high quality fleece, and with shearing cost of anywhere between £1 and £1.50 per head some farmers are just starting to make a profit from wool. With this in mind spending a little time and thought on fleece quality can pay dividends and certainly nutrition can significantly affect fleece quality.

Modern farming techniques and the ability to make more use of forage has resulted in that between 50%-100% of your stock's diet might be dependent on home grown forage. Ewes for example will only receive a concentrate diet for perhaps 14 weeks/ year leaving the other 9 months purely relying on forage.

As demands on production and performance put even greater pressure on livestock we must question why it is that some animals just never reach their genetic potential?

Money spent on expensive rams and bulls is wasted if the market we are aiming for is still unachieved.

Many factors can affect the levels of elements available to the animal, soil type, plant species, time of year, stage of growth, fertiliser application, and environmental conditions.

Stockmen generally have a very good understanding of energy and protein requirements, however in reality, few understand the implications of low mineral/trace element status on their farms or the requirements of vitamins to enable many of these elements to work properly other than cobalt deficiency causing ill-thrift, or 'pine' in weaned lambs; selenium deficiency linked with 'White Muscle Disease' and infertility in cattle; and 'swayback' problems resulting from copper deficiencies. However whilst a trace element deficiency is often blamed for poor production, rations short of energy or the presence of gut parasites or liver fluke, are also often common causes of ill-thrift. The clinical signs associated with trace element deficiencies in sheep in particular can be slow to develop. The only sign may be lighter weights or poorer lambs at slaughter. **A deficiency state should always be confirmed by independent testing and advice before supplementing stock with extra trace elements.**

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Geology and soil

There are 92 naturally occurring elements found in soils, however only 27 of these are classified as essential minerals for animals. Essential minerals are required for maintenance and growth, reproduction and health and these are divided into 2 groups dependent on their concentration in the body, namely the Major or Macro elements and the Micro or Trace elements. Without mineral elements, the macronutrients of protein, carbohydrate and fat, which provide the ruminant animal with energy for growth and production, would be worthless. The reason for this is they contribute to the oxygenation of blood, repair of cells and tissue and development of rumen micro-organisms.

The main reason for different trace element deficiencies throughout the World is variable geology and soils. Cattle and sheep production is largely grass and forage based. If the soil cannot supply sufficient trace elements to the plants that animals are eating, a deficiency will occur. This is more likely to show up where the ration is mainly grazed grass or conserved forage, such as a spring calving herd fed no concentrates or minerals, store cattle or grass finished lambs.

Trace Elements (TE) in herbage vary according to plant species, with weed plants and clover showing higher in TE's than grass, while chicory can show higher Zn and Cu. Re-seeding can reduce trace element intake by reducing the diversity of plants and herbs present. Rapidly growing, lush pasture following fertiliser application will also have lower TE content. The TE content of plants can vary widely even in the same soil.

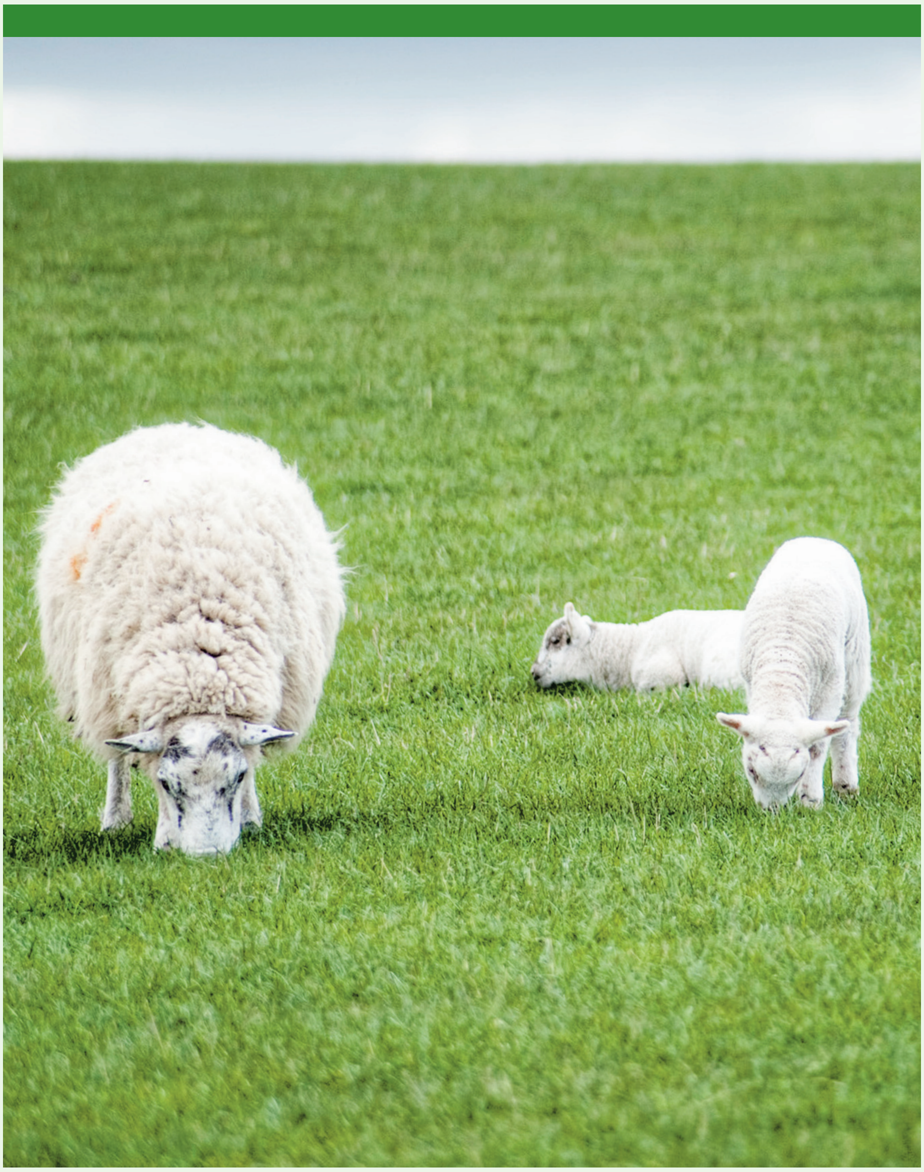
Soil derived from acid rocks such as granite is low in TE's while light sandy soils contain less TE's than clay soils, however poorly drained soils, and soil compaction are far more likely to lead to the risk of induced Cu deficiency due to the antagonist molybdenum resulting in poor live weight gain, fertility and scouring lambs. Sulphur and iron are also antagonists of Cu and can also reduce the availability of Cu to livestock (see Forage Mineral Report). It should also be noted that excessive liming will reduce herbage cobalt levels but increase the amount of molybdenum present resulting in less available copper as well.

Net requirements are affected by the productive capacity of the species or breed, the rate of production allowed by other dietary constituents – notably energy – and the environment. Animals may adjust to a suboptimal mineral intake by reducing the concentration of mineral in tissues or products. Thus the tensile strength of wool fibres may be reduced in order to conserve minerals for more essential functions like growth, fertility and lactation.

As every sheep farmer aim is to maximise performance and production from the flock every aspect from lambing % through to lambs reared, feeding costs and ultimately the wool clip need to be looked at.

The amount of wool that a sheep produces depends upon its breed, genetics, nutrition, and shearing interval. Generally, wool traits are highly heritable, however what most directly influence the value is weight, fibre diameter, length of staple and cleanliness.

Wool has several qualities that distinguish it from hair or fur, namely it is crimped, elastic, and grows in staples. The term wool is



usually restricted to describing the fibrous protein derived from the specialized skin cells called follicles in sheep. Wool is a protein fibre, composed of more than 20 amino acids. These amino acids form protein polymers. Wool also contains small amounts of fat, calcium and sodium. Nutrition plays an important role on the wool growth of sheep. By nature sheep are grazing animals and nutrients from pasture helps the animals for maintenance and as well as production. During the periods of poor pasture growth or when the quality of pasture is poor, there is a reduction of total fleece yield as well as in the quality of the fleece. Proper wool growth requires all the important nutrients like amino acids, carbohydrates, minerals and vitamins. Adequate nutrition increases both the length and diameter of the wool fibre.

Nutrient requirements for wool production

Breeds of sheep in Asian/African Countries have lower body weight and growth rate in comparison to Native breeds, besides genetic makeup, inadequate nutrition is the major factor responsible for low growth and production. Although the wool producing capacity of a sheep is determined by its genetic makeup, it will be influenced by factors like nutrition. Therefore sheep should be fed according to their nutrient requirements. Nutrient requirements vary by the age and size (weight) of the sheep and their stage and level of production. Nutrients like energy, protein, minerals and vitamins all play an important individual but harmonious role in wool production. Feed represents the largest single cost in all types of sheep production and thus the rations must be formulated to support optimum production, must be efficient and economical to feed, and must minimize the potential for nutrition related problems.

Energy intake and wool growth

Energy makes up the largest portion of the diet and is usually the most limiting nutrient in sheep diets. Carbohydrates, fat, and excess protein in the diet all contribute towards fulfilling the energy requirements of sheep. Carbohydrates are the major sources of energy. Concentrates (grain) contain starch, which is a rich source of energy. Forages contain fibre or cellulose, which is not as rich in energy as starch. Meeting energy requirements without over or under-feeding animals is one of the producer's biggest challenges. Energy deficiency is the most common nutritional deficiency in sheep. An energy deficiency will manifest itself in many ways, as for example, in growing animals, an early sign of energy deficiency is reduced growth, then weight loss, and ultimately death. In reproducing females, early signs of an energy deficiency are reduced conception rates, fewer multiple births, and reduced milk production. With restricted energy consumption, wool growth slows, fibre diameter is reduced, and weak spots (breaks) develop in the wool fibre.

Forage Mineral Report

SAMPLE TYPE	Grass	FARMER	01/07/11 - 07/03/12
SAMPLE REF	2012	FIELD ID	Mean 675 Samples
DISTRIBUTOR	J G Animal Health	POSTCODE	
DISTRIBUTOR'S REF		DATE	7 March 2012

MINERAL ELEMENT (DM BASIS)			ASSAY	VERY LOW	LOW	MEAN	HIGH	VERY HIGH
Calcium	Ca	%	0.68	0.3	0.5	0.6	0.7	0.9
Phosphorus	P	%	0.34	0.2	0.3	0.35	0.4	0.55
Magnesium	Mg	%	0.21	0.1	0.15	0.2	0.25	0.4
Potassium	K	%	2.96	0.5	1	2	3	5
Sodium	Na	%	0.20	0.1	0.2	0.25	0.3	0.4
Chloride	Cl	%	1.01	0.3	0.6	1	1.4	2
Sulphur	S	%	0.25	0.1	0.15	0.2	0.25	0.4
Cation-Anion Balance		meq/kg	403	50	100	200	300	500
Manganese	Mn	mg/kg	163	50	75	100	125	200
Copper	Cu	mg/kg	8.1	5	8	10	12	15
Zinc	Zn	mg/kg	35.1	25	40	60	80	130
Cobalt	Co	mg/kg	0.21	0.1	0.2	0.25	0.3	0.4
Iodine	I	mg/kg	0.89	0.25	0.5	1	1.5	2
Selenium	Se	mg/kg	0.09	0.05	0.1	0.15	0.2	0.25
Iron	Fe	mg/kg	441	50	100	150	200	350
Aluminium	Al	mg/kg	199	25	50	100	150	300
Molybdenum	Mo	mg/kg	1.87	0.1	0.35	0.8	1.25	2
Relative Copper Antagonism								
Soil Contamination Index								

Example of a detailed Forage Mineral Report Highlighting Copper Antagonist's Iron / Molybdenum

Protein intake and wool growth

Protein is usually the most expensive part of the diet of sheep. Since the rumen synthesize protein from amino acids, the quality of protein is more important than the quantity. Protein requirements are highest for young, growing lambs and lactating ewes. Although it is clear that wool growth is determined by feed intake, understanding the true nutrient requirements or costs of wool production is far more complex.

Microbial protein synthesis in the rumen and its availability for digestion and absorption in the intestine is more closely related to the intake of digestible energy by the animal than to the protein content of the diet. Although wool growth increased with increasing digestible organic matter intake, its affect is consistent with its probable effect on microbial protein synthesis in the rumen. Thus it would appear that the apparent response in wool growth to an increase in organic matter or energy intake is to the increased supply of microbial amino acids reaching the lower gastro intestinal tract.

The wool fibre is primarily protein, this wool protein contains a high proportion of the high-sulphur amino acids cysteine, (10% in wool) and it has been shown that variation in the availability of the sulphur containing amino acids to the follicle can affect both fibre growth rate and fibre composition (Corbett, 1979). Sulphur containing amino acids play a major role in wool growth. The short supply of sulphur containing amino acids cysteine, and methionine often limits wool growth, and the supply of lysine is also reported to be important.

Mineral intake and wool growth

Macro-minerals are required in large amounts. They include sodium (Na), chloride (Cl), calcium (Ca), phosphorus (P), magnesium (Mg), Potassium (K), and Sulphur (S). Micro-minerals are required in small amounts and include iodine (I), copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), molybdenum (Mo), cobalt (Co), selenium (Se), and fluoride (Fl), are required in small amounts. Minerals can influence wool growth by affecting feed intake (Na, K, S, P, Mg, Co and Zn), by altering rumen function and hence the supply of nutrients flowing from the rumen (S, Na, K and Co) or by directly disrupting metabolism within the sheep (Zn, Cu, Se, I and Co). The wool matrix contains significant quantities of calcium, potassium, sodium, zinc, copper, manganese, iron and selenium (Lee and Grace, 1988), but only copper, zinc, iodine and possibly selenium alter follicle function and wool growth directly.

The macro mineral Sulphur (S) plays an important role in wool production. Clean wool is composed of complex protein keratin which contains about 20 amino acids in many polypeptides and has a sulphur content varying from 2.7 to 5.4% of the fibre weight. Most of the S is present as cysteine, with smaller amounts as cysteine and methionine (McGuirk, 1983). Infusion of 2.0 g cysteine or 2.46 g methionine per day increased wool production by 35 to 130% and the S content by 24 to 35% (Reis and Schinckel, 1963).

Copper plays a very important role in maintaining quality of wool fibre. A deficiency of copper, either in the ration or induced by high levels of iron, sulphur and molybdenum in the diet, results in de-pigmentation of the wool, with production of wool that lacks crimp and has low mechanical strength and a lustrous appearance. De-pigmentation of the wool is caused by low activity of the copper containing enzyme tyrosinase. Zinc deficiency on the other hand results in a marked reduction in wool growth, over and above that associated with the reduced feed intake induced by the deficiency. Some fibres are shed, and the fibres that are produced lack crimp and are brittle. Cell division in the follicle bulb is marginally reduced by zinc deficiency, but the major effect appears to be on the keratinization of the fibre. Selenium also plays a role in wool growth. Its deficiency reduces wool growth without a reduction in feed intake. While the exact mechanisms involved are not known, many of the selenoproteins have key metabolic roles as antioxidants and affect the oxydation status of cells. Uncontrolled peroxidation during severe selenium deficiency causes necrosis due to oxidative damage to cellular macro-molecules and free radicles.

Copper is one of many enzyme systems in the body vital role in development of proteins – collagen and keratin – essential in bone, skin and wool growth and resulting loss of crimp and pigment, formation of nerves and haemoglobin. Excesses of iron, molybdenum and sulphur in forage can form complexes with copper in the rumen and prevent absorption resulting in poor coat quality and loss of crimp. While a more obvious signal may be seen in lambs scouring, where a faecal egg count has shown there to be no worms, the result of contaminated fleece and fly strike lead to reduced value and additional work of dagging or crutching.

Cobalt deficiency often manifests as, ill-thrift, poor appetite, open fleece, tear staining around eyes.

Many shearers will comment on the dryness of fleece at shearing, this dryness, often results from a mineral deficiency will result in poorer fleece quality with the inability to remove the fleece in its entirety and will significantly reduce its value.

Vitamins intake and wool growth

Vitamins play an important role in wool production. Fat soluble vitamins namely Vitamin A, D and E are required in sheep. Vitamins A and D3 probably have direct effects on follicle function, as both have specific receptors in various parts of the follicle. Vitamin K is essential for blood clotting. The levels of B Group vitamins are essential to help ensure adequate utilization and absorption of amino acids, carbohydrates and fats. A deficiency of a vitamin may reduce or completely inhibit wool fibre growth, by reducing the feed intake of the animal thereby impairing the supply of substrate to the follicle, by inhibiting the activity of enzymes involved in protein or energy metabolism and reducing the production of nucleic acids required in the follicle for cell division. Thiamine (vitamin B1) is essential for carbohydrate absorption and energy production, with feeds like cabbage and kale low in B1, resulting in show animals having a higher requirement.

Pyridoxine (vitamin B6) is required for amino acid metabolism in general and in the trans-sulphuration reaction in which methionine is converted to cysteine. Biotin (vitamin H) may be involved in follicle function, because it is required for nucleic acid synthesis which affects DNA of the cells. Folic acid (vitamin B9) is essential for the conversion of glycine and histidine to other amino acids, purines and thymidine, thereby contributing to cell division and protein synthesis. Vitamin BI2 is a cofactor in methionine synthesis, for a range of molecules, it is also essential for the activity of methylmalonyl coenzyme A (CoA) isomerase, a key enzyme in the production of glucose from propionate.

The only direct demonstration of a vitamin deficiency affecting wool growth occurred in pre-ruminant lambs supplied with diets deficient in Folic acid (Chapman and Black, 1981). The wool lacked crimp and in several cases fibre growth ceased completely, despite the fact that the animals were gaining weight. Provision of folic acid alleviated the condition, supporting the notion that this vitamin is essential for wool growth. While microbial synthesis of the B-group vitamins in the rumen means that adult ruminants are unlikely to suffer deficiencies of these vitamins, their effect on rumen function may reduce microbial supply. The presence of 'antivitamin' compounds in feeds (e.g. anti-thiaminase in bracken) may also induce a deficiency resulting in poor or lower performance.

Conclusion

Nutritional augmentation of wool production can never be economical in real terms, however much it affects wool yield and quality. However looking at the broader picture, additional supplemental nutrition does have a significant bearing on growth, reproduction, lactation and production as well as general health and wellbeing, therefore influencing economic return from sheep production and if this subsequent improvement in nutrition has a financial benefit in wool quantity and quality, increased profitability is a likely consequence. Understanding more with regards to nutrition and livestock performance on your own farm is greatly enhanced after detailed forage analysis, explaining exactly why the forage you feed, may or may not, be similar to that of your neighbour. ■