Forage Crops Mineral Advice Sheet

Farm Advisory Service

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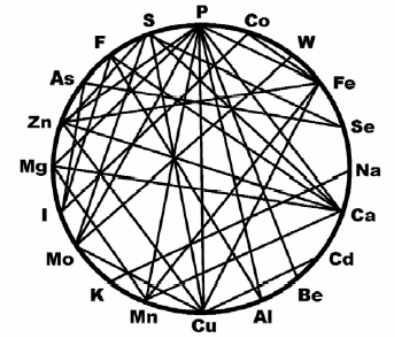
The popularity of utilising forage crops as winter feeding in the autumn and winter has increased in the UK.

Nutritionally forage crops are an excellent source of energy and good source of protein (although root crops tend to be at the lower end). This fact sheet will focus on the main mineral requirements of the animal to consider when grazing/ feeding forage crops.

Productivity, health and fertility of the animal can be compromised if adequate minerals and vitamins are not supplemented. The four main brassicas used in grazing systems are: kale, swedes, forage rape/hybrids and turnips. Fodder beet is another commonly grazed forage crop however it belongs to the Beta vulgaris family and is not part of the brassica family.

Mineral supplementation can seem daunting, as shown in image 1 there are multiple interactions to consider. Then you must weigh up the relevant requirements, and costs of adding minerals versus the potential negative production effect with no supplementation. When making these choices taking a holistic approach is the best way to make decisions to suit your system.

Image 1: Mineral Interactions



This fact sheet contains guide figures for mineral and trace element analysis for the commonly grazed forage crops, however there are many factors which can affect mineral content (e.g. variety, climate, soil, leaf: bulb ratio). Therefore, taking a representative sample of the forage crop being fed for mineral analysis will allow a more accurate mineral plan to be made for your farm. Also finding out the status of your animals blood analysis or a liver biopsy for copper and cobalt, is worth considering as evidence for a particular issue.

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Anti-nutritional factors:

Brassicas' contain glucosinolates which hydrolyse in the rumen to produce goitrogens. Goitrogens interfere with iodine absorption and inhibit thyroxine synthesis. They also contain high levels of antagonists, for example brassica's are high in sulphur, an antagonist of copper. The majority of sulphur in brassicas are contained in the anti-nutritional factor; S-methylcysteine sulphoxide (SMCO) which causes damage to red blood cells and can lead to haemolytic anaemia. Soil particles will also contribute to the dry matter intake of livestock grazing forage crops, potentially inhibiting mineral and trace element availability.

Image 2 shows a sheep with an enlarged thyroid gland (goitre) as a result of iodine deficiency.

Major Minerals

Calcium and Phosphorous: Brassicas are high in calcium. High levels of calcium can be an issue for cows/ewes (dairy cows particularly at higher risk) in late pregnancy, as this can predispose them to hypocalcaemia post birth if not balanced with low calcium forages, for example straw and hay.

Fodder beet bulbs are low in calcium and phosphorous, however the leaf has a high content of calcium and moderate levels of phosphorous. Therefore, the proportion of bulb to leaf will have a big effect when making supplementation decisions. In areas where phosphorous is low in the soil and where uptake of the plant can be relatively low, maintaining the leaf is vital. If there is a low proportion of leaf then phosphorus deficiency can be a problem.

Cases of clinical phosphorous deficiency are usually seen after the winter period and generally only in high producing dairy cows. In these cases, it was reported that dairy cows on high levels of fodder beet were more susceptible to cases of milk fever, however those affected by phosphorus deficiency do not respond to calcium supplementation. Phosphorus deficiency is easily corrected by supplementation, for example in the form of dicalcium phosphate.

In beef cattle phosphorous deficiency presents differently, as poor production, with poor intakes resulting in lower liveweight gains. However, it does tend to be more rarely seen as their phosphorous requirements are comparably lower to a high yielding dairy cow. The best mitigation strategy is improving agronomy of the beet to ensure there is a good proportion of green leaf.

For lambs they should not require supplementation with phosphorous unless diagnosed with a deficiency. The Ca: P ratio is important to reduce risk of urinary caliculi which can affect male lambs, although generally more of a concern on concentrate fed lambs. Target is at least 2:1; Ca: P ratio.

Potassium: Potassium is an antagonist to magnesium therefore if not balanced correctly will predispose stock with high magnesium requirements (cows in late pregnancy and lactating cows/sheep) to a magnesium deficiency. Table 1 shows the potassium levels are particularly high in kale, rape and fodder beet. Table 2 shows the requirements of each livestock class are easily met and no supplementation is required for potassium.

Magnesium: The magnesium content of forage crops is low. The recommended intakes of magnesium for beef cows are 20-30g/cow/day (the upper level being the target for a lactating beef cow), however if the potassium level is above 20-30g/kg DM then 30-40g of magnesium/cow/day is the recommended target due to the antagonism from potassium.

Example: If a suckler cow is grazing kale at 70% of her DMI (around 7kg of dry matter) she will receive 7 x 1.64 g/kg DM (of magnesium). She will receive roughly 3g/day from grass silage. From the basal ration she is receiving 14.5 mg/day therefore below the target of 30-40g/day on a high potassium crop.

Therefore, magnesium supplementation is required for beef and dairy cows grazing forage crops.

Sulphur: As mentioned in the anti-nutritional factors section brassicas are high in sulphur, most of which is contained in SMCO. Sulphur is an antagonist to copper, therefore locking up what copper is available and making this unavailable to the animal. Sulphur supplementation should not be required when grazing forage crops.

Sodium: Sodium is an important mineral in controlling the osmostic pressure in the acid-base balance of the body and is also closely linked to feed intake (palatability). The sodium content of forage crops should be sufficient to meet requirements.

Table 1: Major minerals contents in brassica and fodder beet (g/kg DM)

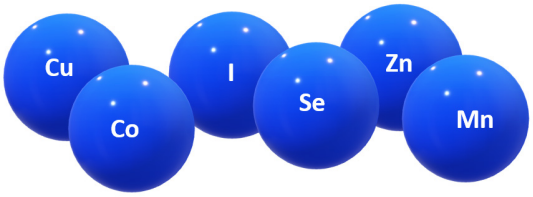
Feed	Ca	P	Mg	S	Na	K
Kale (Brassica)	15.2	3.26	1.64	5.84	1.2	31.7
Forage Rape (Brassica)	21.7	5.8	2.2	4.9	0.95	26.8
Swede (Brassica)	4.0	2.5	1.0	5	2.0	18.7
Turnip (Brassica)	5.0	3.0	1.0	6	5.0	20
Fodder Beet bulbs (Beta vulgaris)	1.5	1.2	1.5	0.49	2.0	24.9
Fodder Beet Tops	10	2.0	7.0	-	18	-

Table 2: Major mineral requirements of a beef cow, ewe, lamb and dairy cows (g/kg DM):

Animal	Calcium	Phosphorous	Magnesium	Sulphur	Sodium	Potassium
Beef Cow	3.6	2.8	2-3	1.5	1.0	10
Ewe	6.7	5.4	1.32	1.3-2	2.5	5-6
Lamb	4.3	4*	1.3*	1.8	0.7	5
Dairy Cow (lactating)	8	3.8	2.5 – 3.5	2	2.8	14

- Based on 75kg pregnant ewe (AHDB Feeding the Ewe)
- Based on a 30kg lamb growing 250g/day (NRC 2007)
- Dairy Cow Requirements based on NRC 2001 and Bill Weiss recommendations
- Beef cow Requirements based on NRC 2016
- Male lambs aiming for Ca: P ratio of at least 2:1. P< 4.6g/kg DM and Mg <2.3 mg/kg DM

Trace Elements:



Forage crops are low in most trace elements, particularly copper, cobalt, iodine and selenium. The presence of high levels of sulphur and anti-nutritional factors in brassicas further exacerbates the deficiencies.

Copper: Copper is essential for fertility, ovulation and growth. Absorption in young stock (pre-ruminants) is around 50% whereas this drops to around 1-5% in mature livestock. Copper is stored in the liver which contains more than 70% of the total body copper.

Sulphur forms insoluble complexes with copper in the rumen, leaving the copper unavailable. Table 3 shows the low level of copper in each of the forage crops, in addition to table 1 which shows the high sulphur content in brassicas. From table 4 the requirements of each livestock class cannot be met from the forage crops alone therefore supplementation is advised. Caution is advised for supplementing sheep, particularly sensitive breeds (e.g. Texels and Suffolks) which are prone to copper toxicity.

Cobalt: Cobalt is a necessary component for the rumen micro-organisms to produce vitamin B12. A cobalt deficiency largely manifests as a failure to thrive, particularly in young stock. Weaned lambs can be particularly susceptible to cobalt deficiency due to milk being removed. The cobalt content of forage crops are marginal to low therefore supplementation is advised.

Iodine: As mentioned in the anti-nutritional section brassicas are a feed that contain goitrogens which interfere with iodine absorption. Iodine is an essential component of the thyroid hormones. The classical sign of iodine deficiency is thyroid enlargement (goitre) due to the compensation mechanism of the thyroid gland triggered by the lack of thyroid hormone.

The requirement of iodine in the presence of feeds containing goitrogens increases by 2-4 fold to compensate therefore supplementation is required. Although fodder beet is not a brassica it's relatively low iodine content will not be sufficient to meet normal requirements of each livestock class (see tables 3&4).

Selenium: Selenium forms part of a number of enzymes and proteins in animal tissues. It is a component of GSH-PX an enzyme which inhibits and destroys naturally occurring peroxides that cause cell damage. When there is deficiency harmful free radicals may accumulate leading to clinical disease known as white muscle disease. It is also a vital part of the immune system, therefore a deficiency can leave animals more prone to infectious diseases. The selenium content is marginal/low therefore supplementation is advised.

Zinc: An enzyme activator with an essential role in the immune system and is largely involved in the synthesis and metabolism of proteins and carbohydrates. Zinc has many roles and is essential for skin, hair and hoof health. Most forage crops will meet requirements of each livestock class, excluding kale and swedes which appear to be marginal/low from table 3 guide values.

Manganese: Manganese is involved in enzyme activation, functioning of the brain and nervous system, connective tissue formation and growth and bone development. Forage crops content of manganese is marginal to low. Manganese is a generally poorly absorbed mineral and livestock do not have appreciable stores; therefore supplementation is advised.

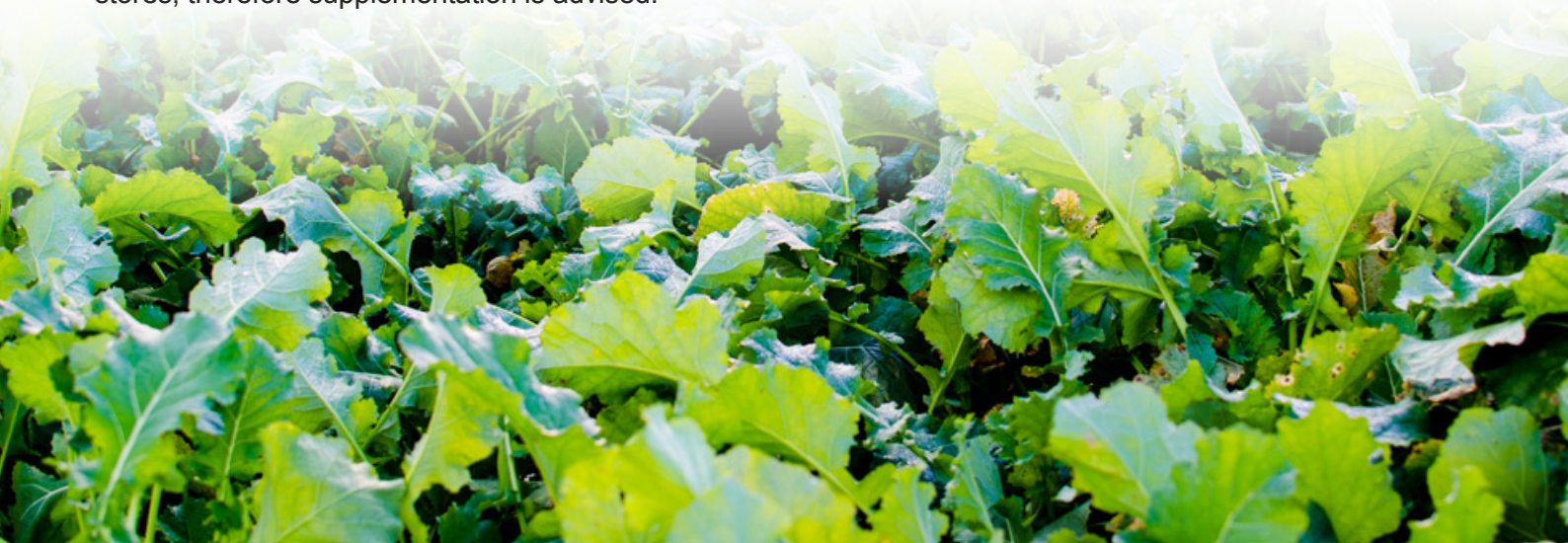


Table 3: Trace elements content of brassica and fodder beet (mg/kg DM)

Feed	Copper	Cobalt	Iodine	Selenium	Zinc	Manganese
Kale	1.64 - 8.7	0.05 - 0.9	0.26 - 0.62	0.12	15.4 - 29.4	15 - 36.7
Forage rape	6.0	-	-	-	42	39
Rape/kale hybrid	6.4	0.36	1.7	0.1	47	80.8
Swede	3.8	0.1	0.3	0.04	20	10
Turnip	6.27	0.4	0.7	0.017	39.4	88.13
Fodder Beet bulbs (Beta Vulgaris)	10	0.05	0.05	0.01	100	20.3
Fodder beet tops	20	0.2	0.1	0.1	40	-

Table 4 Trace element requirements of a beef cow, ewe, lamb and dairy cows (mg/kg DM):

Feed	Copper	Cobalt	Iodine	Selenium	Zinc	Manganese
Beef Cow	10	0.15	1-2	0.1	30	40
Ewe	6	0.11	1-2	0.1	40	40
Lamb	6.1	0.2	1-2	0.2	26.7	22.9
Dairy Cow (lactating)	15	0.15	1-2	0.3	60	40-50

- Based on 75kg pregnant ewe (AHDB Feeding the ewe)
- Based on a 30kg lamb growing 250g/day (NRC 2007)

+ Requirement when feed contains goitrogens (2 – 4x base level)

- Dairy Cow Requirements based on NRC 2001 and Bill Weiss recommendations
- Beef cow Requirements based on NRC 2016

Methods of Supplementation

Free Access powdered minerals
Cost effective but will require topping up regularly and intakes are not guaranteed

Buckets/blocks
Convenient method of supplementing although can be expensive. Some can also provide additional energy and protein which may be beneficial particularly to cows/ewes in late pregnancy. However, intakes aren't guaranteed.

Bolus
Selective trace element supplementation only and long acting for specific trace elements. However, they are expensive and requires handling of livestock to insert into rumen via the mouth. Also major minerals such as magnesium will not be covered.

Trace element Drench
Provides a top up of essential trace elements at key times. It's a fast-acting treatment to correct animal with known deficiency. Labour intensive for handling and similarly to boluses does not provide macrominerals. The length of time product works for/remains in animal's system is often unknown.

Trace element Injection
Can target specific animals for treatment for clinical deficiency. Trace elements go direct into blood stream and availability not affected by antagonists in forage. This method can only be done under veterinary guidance. Method is labour intensive and requires animal handling and will be expensive.