Scottish Natural Heritage

Guidance note

The effects of supplementary feeding on species-rich grasslands

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This note is based on guidance written by Paul Chapman of Scotland's Rural College

What you can do

- Supplementary feeding of livestock on species-rich grassland is damaging and should normally be avoided. The following guidelines describe ways to avoid the need for supplementary feeding, and to minimise the damaging effects where it is considered unavoidable.
- Unless there is a specific benefit to a site from out-wintering or supplementary feeding (for example the management of foraging habitat for birds or for bracken control), avoid grazing species-rich grassland from late December to March and ensure that the vegetation has been grazed down before this period.
- Where livestock cannot be removed from December to March, aim to retain some deferred grazing for this period and use the minimum supplementation with concentrates required to allow livestock to continue grazing the vegetation.
- Avoid using bulky complete feeds such as silage, as this will discourage grazing of the sward and increase the risk of nutrient enrichment.
- Where only more demanding livestock types are available for grazing during the growing season (such as growing cattle of continental breeds) it may be possible to minimise the effects of lower livestock growth rates by rotating groups of animals through the site for short periods. Alternatively, consider less intensive systems that can accommodate lower growth rates and longer finishing periods.
- Where supplementary feeding is considered necessary for animal welfare or to maintain grazing on the site, the aim should be to encourage grazing of the sward through the use of concentrates that meet and do not exceed the requirements of the livestock. You may need an analysis of the nutritional value of the sward and advice from an independent livestock nutritionist.
- Where mineral supplementation is required, use products with a low-moderate phosphorus content (<5%) to avoid nutrient enrichment.
- Where supplementary feeding is considered necessary, locate feeding sites on drier parts of the site to reduce sward damage, but avoid areas of particular botanical interest or archaeological or historical sites.
- Do not feed livestock within 10 metres of any watercourse (see General Binding Rules 19).
- Where small amounts of supplementary feed are used to encourage grazing of the sward (such as feed buckets or mineral licks), these should be rotated around the site. If larger amounts of supplementary feeding cannot be avoided, it may be preferable to use a sacrificial feeding area, depending on the size and variety of habitats on the site.
- Land managers in receipt of agricultural subsidies must abide by Good Agricultural and Environmental Conditions (GAEC) to prevent the erosion of feeding areas.
- See the SRUC guidance: Valuing your soils: Practical guidance for Scottish farmers for additional information on how to value and protect your soils, helping you to make your farm business more profitable.

Introduction

Livestock grazing is essential for keeping most species-rich grassland sites in good ecological condition, by preventing a build-up of dead plant material and maintaining a structurally and botanically diverse sward. However, the need to avoid grazing at certain times because of the ecological interest of the site (for example to allow plants to flower or to allow invertebrates or birds to breed successfully) may result in the site being grazed at a time of year when the vegetation has a low nutritional value. In addition, farm specialisation and the trend towards more productive and nutritionally demanding livestock breeds means that it may be difficult to find livestock that will thrive on some species-rich grassland sites.

Supplementary feeding is not normally allowed on designated sites or on other species-rich sites being managed under agri-environment schemes. However, there is increasing pressure to consent to this practice, particularly where hardy traditional native breeds are no longer present and the only breeds available for grazing are highly productive commercial livestock such as continental cattle. This guidance note will help you to make informed decisions on the need for supplementary feeding on species-rich grasslands, balancing the need for grazing with the potential for damage caused by supplementary feeding and determining if there are alternative strategies that will help avoid potential management conflicts.

The agricultural need for supplementary feeding

To understand why a livestock manager might want to provide supplementary feeding for livestock on species-rich grassland it is useful to have a basic understanding of livestock nutritional needs and how these are met by grasslands of different types.

The nutritional requirements of livestock

At a very simple level, the quality of any livestock food can be expressed in terms of three key nutritional requirements:

Energy: usually expressed as metabolisable energy (ME) and measured in Megajoules (MJ) per kg of dry matter (DM) of the feed.

Protein: often expressed as crude protein (CP) which is measured as a percentage of the dry matter of the feed and is directly related to nitrogen content.

Minerals: seven major minerals (Calcium, Phosphorus, Potassium, Sodium, Chlorine, Magnesium and Sulphur), along with a number of trace elements, are required in the diet of livestock (Suttle, 2010). Phosphorus (usually measured as g/kg of dry matter) is the most important in this context as species-rich grasslands usually only occur on soils with a low level of Phosphorus. In calcareous grasslands a very high ratio of Calcium to Phosphate may be detrimental to metabolism and bone development.

A certain amount of **fibre** in the feed is also important to maintain digestive health, but as fibre content increases, the metabolisable energy decreases and the time taken for digestion increases. The amount of forage that ruminant livestock such as cattle and sheep can eat is ultimately limited by the rate at which food can be digested. If the energy, protein or mineral content of the forage is too low then livestock will not be able to meet their nutritional requirements and will start to lose condition, with implications for production and animal welfare.

Table 1 shows guideline figures for the nutrient content of grassland that would be needed by different categories of livestock to meet their nutritional requirements by grazing alone. There may be variation between breeds and between animals in good and poor condition but young animals that are growing, and breeding animals that are in the late stages of pregnancy or lactating, invariably require the highest quality forage. Dry beef cows and sheep generally have the lowest nutritional requirements since they are not growing and do not have the high demands of milk production (in fact some weight loss may be desired if the animals have put on too much weight during the preceding lactation).

Table 1: Guideline figures for the quality of forage required by different categories of grazing livestock (adapted from Cottrill, Dawson, Yan, & Xue, 2009 and reviewed by C. Morgan, livestock nutritionist, SAC Consulting)

Livestock requirements	Energy (ME) MJ/kg dm	Protein (CP) % dm	Phosphorus g/kg dm
Dairy cow (Lactating)	12	17-18	3-4
Dairy cow (Dry)	8.5	12-14	2.5
Beef cow (Dry)	8	9	2.5
Beef cow (Lactating)	9	11	3
Growing beef cattle	10.5	15-16	3
Finishing beef cattle	11	12-14	2.5
Ewe (maintenance)	8	9	1.5
Ewe (6 weeks ± lambing)	10	16	2.5
Growing lambs	11	16	2

Nutritional value of semi-natural grasslands

Semi-natural grasslands usually produce a lower yield of grass than agriculturally improved and fertilised grassland (Talllowin & Jefferson, 1999), which means that they support lower stocking rates for grazing. However, maintaining even those lower stocking rates is dependent on the quality of the grazing being adequate to meet the nutritional demands of the livestock.

Table 2 shows typical figures for the energy, protein and phosphorus content of agriculturally improved grassland and for two broad categories of semi-natural grassland. The figures for semi-natural grassland can vary considerably, and there is potential for sheep in particular to selectively graze the plants with the highest nutritional quality within the sward (some herb species may be particularly rich in minerals that are deficient in the sward as a whole). However, it is usually the case that semi-natural grasslands are lower in all three main nutritional requirements compared with improved ryegrass pastures.

The grasslands with the lowest nutritional value tend to be from the Purple Moor Grass and Rush Pastures priority habitat, also called fen meadow (NVC Communities M22 to M26). Some Lowland Meadows priority habitat (NVC communities MG3, MG5 and MG8) may have energy levels close to those of average improved pasture, but they will invariably have lower Phosphorus levels

Table 2: Typical figures for the quality of different types of grassland (Talllowin & Jefferson, 1999) (Fisher, 2013)

	Nutrient content of grazed vegetation		
Grassland type	**Energy (ME) MJ/kg**	**Protein (CP) %**	**Phosphorus g/kg**
Improved ryegrass pasture (good)	12	22	4
Improved ryegrass pasture (average)	10.5	18	3
Purple moor grass and rush pasture	6.5 - 8	8 - 12	0.7 - 1.0
Lowland Meadow	8 - 10	8 - 12	1.0 - 1.5

It is clear from Tables 1 and 2 that good quality agriculturally improved grassland is capable of meeting the nutritional requirements of all categories of livestock. By contrast, semi-natural grasslands can generally meet the energy and protein requirements of dry cows and ewes, but probably not those of more demanding livestock such as growing and finishing beef cattle. While such stock may be able to survive on species-rich grassland without welfare issues, they may not gain weight at the rate that is sought by the farmer in commercial grazing systems. Liveweight gains of 0.75 – 1.00 kg/day are typically sought in modern beef farming systems, and although such rates have occasionally been recorded on species-rich lowland meadow systems in England, gains are usually lower than this (Tallowin & Griffith, 2013). On less productive upland or acid grasslands that are more common in Scotland, liveweight gains are likely to be much lower or non-existent. Phosphorus levels are likely to be sub-optimal for most livestock on most species-rich grasslands, although they may be just about sufficient for dry cows and ewes on some sites.

The fibre content of grass (improved or semi-natural) increases as the plant matures, with an associated decrease in digestibility and nutritional quality. The nutritional value of grazing is therefore highest in the spring and early summer and declines as the growing season progresses, particularly where the vegetation is allowed to mature over the summer for deferred grazing in the autumn. Studies of deferred grazing of semi-natural grassland suggest that it is usually around the end of December that dry cows are unable to meet their energy and protein requirements from grazing alone (SAC Consulting, 2009). This may be earlier on poorer quality semi-natural grassland or for livestock in poor condition or if the weather is unusually cold, wet or snowy.

Types of supplementary feed

There is a very wide range of supplementary feeds available for livestock, which can be grouped into four broad categories:

Preserved forages such as hay and silage, can meet all or most of the nutritional requirements of most types of livestock, provided that they are made from agriculturally productive grassland, cut at the optimum time and properly preserved. These are commonly used as winter feeds to replace grazing when vegetation growth has largely stopped, although they can also be used to supplement poor quality grazing. Grass nuts or pellets are made from dried grass and provide a similar complete feed to silage if soaked in water, but if they are fed dry they are more like a concentrate feed and should be used as a supplement to bulky forage (see below).

Root crops such as swedes and turnips also provide good all-round nutritional benefits, except for livestock with particularly high protein requirements such as growing cattle and lactating dairy cows. However, they are relatively low in fibre and therefore cannot entirely replace forage in the diet.

High energy or protein concentrates can include cereals (high in energy) and residues of industrial processing (e.g. oil seed meal – high in protein) either as straight feeds or in the form of a mix of the raw ingredients, pellets, a solid feed block or a feed bucket. They often include supplementary minerals. These are generally low in fibre so must be provided along with forage (grazing, hay, silage or straw) to provide a balanced diet.

Mineral Licks, as their name suggests, provide supplementary minerals only and can be formulated for specific mineral deficiencies. They normally take the form of a solid block or may be contained in a bucket.

Impacts of supplementary feeding

The presumption against supplementary feeding on species-rich grassland sites is based on a number of detrimental impacts that the practice may have on the vegetation, described below.

Poaching / Sward damage

Concentrations of livestock around supplementary feeding sites can cause significant localised damage to the species-rich sward and even complete sward loss. Areas of bare ground of 5-20m2 are commonly associated with supplementary feeding sites with a similar additional area affected by less severe poaching (Kirkham, 2006). Damage is likely to be greatest on soft ground and at permanent (sacrificial) feeding sites. Swards may also be damaged by vehicles carrying supplementary feed onto the site. For these reasons an area of firm ground is preferable for supplementary feeding, provided that it does not have particular botanical interest and is not an archaeological site.

Soil erosion associated with sward damage can also cause diffuse pollution problems, affecting nearby watercourses. It is a statutory requirement under General Binding Rule 19 of the Water Environment (Controlled Activities) (Scotland) Regulations 2011 that livestock feeders must not be positioned where run-off from around the feeders could enter any river, burn, ditch, wetland, loch, transitional water or coastal water, and must not be positioned within 10m of any surface water or wetland (SEPA, 2015). Land managers in receipt of agricultural subsidies must abide by Good Agricultural and Environmental Conditions (GAEC) and must prevent the erosion of feeding areas from overgrazing or heavy poaching by livestock.

There are certain circumstances where poaching caused by supplementary feeding can have a positive impact on the ecological management of a site. For example, where the spread of dense stands of bracken (*Pteridium aquilinum*) threaten areas of greater conservation interest, winter feeding of cattle can help to break up the ground and expose bracken rhizomes to frost damage, reducing the plant's vigour and dominance. However, it is important that livestock are provided with sufficient feed to prevent them from eating poisonous dead bracken fronds. Such management should be used as a short-term measure only, to allow the vegetation to recover afterwards.

Damage caused by poaching and slurry stream flowing into species-rich grassland from supplementary feeding site. ***Elspeth Christie/SNH***

Nutrient enrichment

Species-rich grasslands are usually found on soils of low fertility with nitrogen typically being the limiting nutrient on light soils and phosphorus typically being the limiting nutrient on soils with higher organic matter. Supplementary feed usually contains nitrogen and phosphorus in varying quantities but livestock only assimilate a small proportion of these nutrients in their tissues as they grow, excreting the rest. As a result, there is potential for supplementary feeding to import nitrogen and phosphorus into the soil of species-rich grassland. This can reduce species diversity by favouring more vigorous and competitive grasses at the expense of other species (Kirkham, 2006).

The highest levels of nitrogen and phosphorus are usually found in high protein supplementary feeds, so the risk of nutrient enrichment is greatest with these. The risk will increase as the proportion of the livestock's total feed intake that comes from supplementary feeding increases. However, as the proportion of supplementary feed increases, animals are likely to spend more of their time around the feeding site and enrichment may be localised in this area (possibly compounded by spillage and wastage of feed). Even so, it is important to be aware that enriched feeding areas may subsequently act as a source of nutrients that could be distributed more widely, through leaching or by livestock grazing the enriched area along with the surrounding area.

It is not always the case that supplementary feeding will lead to nutrient enrichment. A species-rich hay meadow which is cut in the summer and where the hay is subsequently fed to livestock overwintering on the site is a relatively closed system. Nutrient enrichment is unlikely to occur although compaction or poaching may still be a problem. Another example is feeding high energy cereal-based concentrates to growing cattle. This will increase livestock growth rates and the amount of nitrogen and phosphorus that is retained in new animal tissue may outweigh the extra amount eaten, resulting in a reduction in the amount excreted. However, the more supplementary feed that an animal gets, the less it will graze the surrounding vegetation. If stocking rates are increased to maintain the same level of grazing pressure then there is likely to be an increase in nitrogen and phosphorus excretion per unit area (Kirkham, 2006).

The timing of supplementary feeding affects the likelihood of nutrient enrichment. During the winter there will be little if any uptake of excreted nutrients by plants compared to the summer when the sward is growing, while rainfall is usually higher than in summer. Consequently, there is more potential for loss of excreted nutrients from the soil through leaching and run-off when supplementary feeding takes place in the winter and therefore less potential for nutrient enrichment (Kirkham, 2006).

Where mineral licks are the only form of supplementary feeding, modelling has shown that a standard 4% phosphorus mineral supplement would result in a relatively modest 24% increase in the amount of phosphorus excreted by cattle, while a 10% phosphorus supplement would almost double the amount of phosphorus excreted (Kirkham, 2006).

Horses are much less efficient at absorbing phosphorus in the diet than cattle and sheep and are therefore likely to pose a higher risk of phosphorus enrichment where this nutrient is being provided in supplementary feed.

In summary, the risk of nutrient enrichment from supplementary feeding can be minimised by ensuring that the nitrogen, phosphorus and energy content of the feed is as closely matched to the livestock's requirements as possible and that the proportion of the livestock's total feed intake that comes from supplementary feed rather than from grazing the species-rich sward is kept to the minimum possible level. This may require a feed ration to be calculated by an independent adviser, ideally based on an analysis of the nutritional value of the vegetation growing on the site.

Localised over-grazing and under-grazing

The use of permanent supplementary feeding areas on larger sites is likely to result in livestock spending more time grazing close to the feeding area and potentially under-grazing more distant parts of the site. The extent of such an effect will depend on other factors such as the amount of shelter available in different parts of the site and the location of water supplies for livestock.

Livestock can be encouraged to spread more evenly across a site if supplementary feeding sites are moved at regular intervals. At sites where there is localised over-grazing and under-grazing in the absence of feeding, perhaps due to factors such as shelter and water supplies, some supplementary feeding, e.g. mineral licks, may help to spread grazing pressure more evenly.

Soil compaction

Localised soil compaction can occur as a result of trampling by feeding livestock or due to vehicle activity associated with supplementary feeding. This may modify the plant communities on the site by restricting root growth and changing soil hydrology, and there is evidence that this reduces species diversity (Clarke, et al., 2008). Compaction leading to waterlogged soils can also reduce profitability. Assessing the suitability of your fields for vehice access and stock density will help minimise the possibility of damage to soil or sward condition. It can be as easy as using a simple 'squelch test' (SRUC, 2016).

Damage caused by vehicle tracks around feeding rings. ***Stuart Smith /Natural Resources Wales***

Contamination by invasive plants

When preserved forage such as hay or silage is brought onto a site for supplementary feeding, there is potential for it to contain seeds of plants not normally found at the site. This may include seeds of agricultural grass cultivars or grassland weeds such as docks (*Rumex* spp.), thistles (*Cirsium* spp.) or nettles (*Urtica dioica*). Good quality hay or silage is usually cut before grasses have set seed and should not contain a high weed burden, so this is most likely to be an issue with hay or silage that has been cut late in the season or from fields with a weed problem. Dock seeds have been shown to survive best in silage with a high dry matter content which has been ensiled for less than eight weeks (van Eekeren, Feher, Smeding, Prins, & Jansonius, 2006).

Management without supplementary feeding

Ideally species-rich grassland should be grazed by livestock that are able to meet their nutritional requirements without supplementation, most likely dry cows or ewes. The site should be grazed at an appropriate stocking rate and for sufficient duration during the summer/autumn to maintain the site in good ecological condition. Livestock should then be removed during the period when winter supplementary feeding is essential (typically late December to March). The need for supplementary feeding may then be eliminated apart from mineral supplementation on the lowest fertility sites, or for rare situations where winter grazing is beneficial for a particular conservation interest: for example, winter grazing has been used to create a short sward rich in invertebrate prey for foraging choughs (*Pyrrhocorax pyrrhocorax*) (Ausden & Bateson, 2005).

Guidelines for supplementary feeding

In practice, farming systems have become highly specialised, with some concentrating on breeding cattle or sheep, some on dairying, others on growing and finishing livestock for meat production and others on arable production without livestock. There is much more emphasis on maximising productivity and using livestock breeds that achieve high growth rates. Farms with breeding cattle are increasingly looking to minimise the duration of the calving period to make management easier. This means that dry cows may be available for a shorter period of the year than when calving is spread out. As a result, there may be constraints on the type of livestock that are readily available for grazing species-rich grasslands, meaning that achieving the ideal grazing regime can be difficult. The following scenarios describe the main situations where there may be a demand for supplementary feeding.

Sites where there is nowhere else to keep livestock during the winter

In most parts of the country it is impossible to maintain any type of livestock over the December-March period without some form of supplementary feeding and if the sward has been grazed down sufficiently to maintain good ecological condition by the start of this period, the livestock will be almost entirely dependent on supplementary feeding with hay or silage to provide their nutritional requirements. High levels of supplementary feeding increase the risk of nutrient enrichment, sward damage and compaction and in these circumstances the best course of action is to remove livestock during this period and keep them elsewhere.

The difficulty arises where there is no alternative wintering area. This may be the case where the species-rich grassland is an isolated site with no farm buildings or alternative fields on the same holding. Or there may be alternative wintering areas distant from the main farm but the time and costs associated with daily feeding make them impractical to use. Or it may be the case that the only alternative wintering site is productive agricultural grassland and winter feeding will damage the sward, resulting in a loss of production in the following season. In these situations the farmer's enthusiasm for the additional costs of off-wintering their livestock may well depend on financial support from a management agreement.

If there is genuinely no alternative wintering area and grazing might cease if livestock cannot be kept on the site throughout the winter, then a permanent, sacrificial feeding area on a low value part of the site will often be the best option. In some situations it might be appropriate to fence this area off to protect the remainder of the site, but this will depend on factors such as the size of the site and number of livestock involved.

Emergency feeding in adverse weather conditions

There may be occasions when unexpected weather conditions such as unseasonal snowfall, flooding or drought mean that livestock are unable to access vegetation for grazing. The ideal solution in this situation is to move the livestock elsewhere for feeding, but if this is not possible some supplementary feeding is likely to be necessary as an animal welfare measure.

Sites where only more demanding livestock are available

On many farms, particularly but not exclusively in lowland areas, the only readily available livestock for grazing species-rich grassland may be young sheep or cattle being grown for meat production. In most modern intensive farming systems the farmer will be looking to maximise liveweight gains in these animals, which requires higher levels of energy, protein and minerals than the maintenance requirements of dry cows and ewes. Even during the summer, young sheep or cattle grazing species-rich grassland without supplementary feeding are likely to show lower liveweight gains than the farmer desires. Where a short period of grazing is required, this may not be too much of a problem, but over a long period the impacts on the farming system may be more significant. Additional costs are associated with keeping animals longer and having to house and feed them in the winter when they could have been finished more cheaply on better quality grass during the summer. For long grazing periods it may be possible to rotate groups of livestock through the species-rich grassland so that each group only grazes the species-rich grassland for a short period. However, this adds time and complexity to the livestock management system when most farms are looking to simplify their systems in order to reduce costs.

Where a farmer is looking to enter a management agreement for species-rich grassland, the aim should be to agree a management strategy that minimises the need for supplementary feeding without compromising animal welfare. Where supplementary feeding is considered necessary, either because of the poor quality of the species-rich sward or because a long grazing period cannot be avoided, the aim of supplementary feeding should be to maximise the intake of forage from the species-rich grassland with the minimum input of supplementary energy, protein and minerals. Hay or silage should be avoided, as explained above. The most appropriate supplement is likely to be a high energy concentrate, balanced to avoid providing an excess of nitrogen and phosphorus, which should be fed at the minimum rate that can be agreed, ideally based on advice from an independent nutritionist.

Sites where mineral supplementation is required

This is the simplest type of supplementary feeding and the one which is likely to cause the fewest problems if properly dealt with. Mineral supplementation is likely to be required on many less productive types of species-rich grassland regardless of the type of stock or time of year (see tables 1 & 2). A mineral lick in block or bucket form can be easily moved around the site to prevent sward damage and soil compaction. The mineral supplement should have a low-moderate phosphorus content (<5%) to reduce nutrient enrichment, and should only be supplied if required and for no longer than necessary.

References

Ausden, M., & Bateson, D. (2005). Winter cattle grazing to create foraging habitat for choughs Pyrrhocorax pyrrhocorax at South Stack RSPB Reserve, Anglesey, Wales . *Conservation Evidence* , 2, 26-27.

Clarke, M., Creamer, R., Deeks, L., Gowing, D., Holman, I., Jones, R., et al. (2008). *Scoping study to assess soil compaction affecting upland and lowland grassland in England and Wales. Research Project BD2304 Final Report.* DEFRA.

Cottrill, B., Dawson, L., Yan, T., & Xue, B. (2009). *A review of the energy, protein and phosphorus requirements of beef cattle and sheep.* Defra Project WQ 0133.

Fisher, G. (2013). *Feed Planning for Cattle and Sheep.* Tried and Tested Partnership.

Kirkham, F. (2006). *The potential effects of nutirent enrichment in semi-natural lowland grasslands through mixed habitat grazing or supplementary feeding.* Scottish Natural Heritage Commissioned Report No. 192 (ROAME No. F04AA101/2).

SAC Consulting. (2009). *Cattle Outwintering Systems - SAC/QMS booklet.*

SEPA. (2015). *The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) - A Practical Guide, Version 7.2.*

SRUC (2016). In preparation.

Suttle, N. (2010). *Mineral nutrition of livestock.* CABI.

Talllowin, J., & Jefferson, R. (1999). Hay production from lowland semi-natural grasslands: a review of implications for ruminant livestock systems. *Grass and Forage Science* , 54, 99-115.

Tallowin, J., & Griffith, B. (2013). *Sustainable Management Systems for Unimproved Neutral Grassland. BD 1460.* DEFRA.

van Eekeren, N., Feher, L., Smeding, F., Prins, U., & Jansonius, P. (2006). Controlling broad-leaved dock (Rumex obtusifolius) in grass clover mixtures. *Grassland Science in Europe, Vol. 11: Sustainable grassland productivity* (pp. 391-393). European Grassland Federation.

Useful links

Diffuse Pollution General Binding Rules (DP GBRs)
http://www.sepa.org.uk/regulations/water/diffuse-pollution/diffuse-pollution-in-the-rural-environment/

Cross Compliance - Good Agricultural and Environmental Conditions (GAEC)
http://www.gov.scot/Topics/farmingrural/Agriculture/grants/Schemes/CrosscompliancesectionCcompliance

Agri-Environment Climate Scheme (AECS) -
https://www.ruralpayments.org/publicsite/futures/topics/all-schemes/agri-environment-climate-scheme/

Valuing your soils: Practical guidance for Scottish Farmers
http://www.sruc.ac.uk/info/120603/farming_and_water_scotland

Specific soil nutrient targets and fertilisers requirements for your crop are provided in SRUC technical notes
http://www.sruc.ac.uk/downloads/120202/technical_notes.

Visual Evaluation of Soil Structure (VESS) test
http://www.sruc.ac.uk/info/120062/crop_and_soils_systems/412/visual_evaluation_of_soil_structure

Cover image: Species-rich grassland near Dumfries. ©Jane MacKintosh/SNH

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