

Outwintering Strategies for Livestock



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Introduction

Outwintering of cattle and sheep is an option that can be explored on suitable farms, from the more traditional methods of grazing on rough grass and woodland areas, to grazing brassicas in the field and newer novel methods such as winter grazing on arable cereals and setting up bale grazing. The success of outwintered systems for ruminants needs careful planning and good stockmanship.

The aim of this guide is to aid decision making for livestock producers who are looking to outwinter stock and what systems may best suit their farm. Outwintering is often considered to reduce high costs associated with winter housing of animals (bedding and buildings) and other benefits can include improved welfare of livestock, reduced feed costs and improving the biology and nutrient status of the soils (if managed correctly).

This guide will evaluate the management and suitability of different wintering options focusing on the period after crop establishment, and does not include agronomy or setting up stages.

Advantages of outwintering:

- **Reducing winter feed costs, especially that of purchased feeds**
- **Reduced housing requirements, taking the pressure off shed space, which could be used for other stock e.g. growing stock or calving/lambing animals**
- **Increasing the production per hectare on the farm**
- **Enhancement of soil fertility**
- **Improving animal health and welfare, with livestock being less prone to respiratory disease**
- **Reduction in the cost of bedding, running of machinery and labour**
- **Fertilisation of land through animals self-spreading their manure**

The choice of outwintering system will depend on the class of stock, farm site and facilities, soil type, weather and other environmental considerations. With variable winter weather in Scotland, it is vital to have a contingency plan in place for times of extreme weather. Conditions such as heavy snowfall or wet ground which could make access for checking stock and providing supplementary feeding challenging.

This guide will focus on 6 main options for outwintering cattle and sheep:

1. **Forage brassica and beet crops**
2. **Deferred grazing**
3. **All grass wintering (sheep only)**
4. **Bale grazing**
5. **Winter grazing of arable crops (sheep only)**
6. **Catch crops**

Section 1 – Management Considerations for Outwintering Systems

Monitoring

It is essential in any system to monitor welfare and animal performance, however, it is especially important in outwintering systems, where there can be additional environmental challenges.

Prior to animals being transitioned onto an outwintering system, they should be body condition scored. Any animals that are below target should be managed separately off the crop, and investigations made as to why they are below target and changes made to their management.

The body condition of livestock grazing should be monitored throughout the winter period and action taken if animals are losing condition. For those losing condition, they should ideally be removed from the group for further investigation and treatment, and not returned until condition has been regained. One common issue with body condition losses on forage crops is poor transition to the crop, resulting in the animals having a low intake (more information on transition in section 2 – forage brassicas and beet crops). If animals are losing excessive condition, veterinary investigation may be required.

If weather conditions mean that animals cannot access sufficient food, for example due to snow, or animals are causing damage to the soil, often when fields are waterlogged, then animals should be removed from the crop. It is useful to have a contingency plan in place for such events. This may be that the animals are housed, straw is put down to offer a dry lie area or they are moved to a different field. In this scenario it is important to avoid any sudden dietary changes which can upset the rumen. For example, if housing animals that were grazing fodder beet, lift some fodder beet and feed indoors.

Good foot health is important for livestock, particularly on systems where animals are grazing a long, narrow feed face or round a ring feeder where the ground can become poached and contaminated quickly. Any animals seen to be lame should be removed from the group and treated. If it is a whole herd/flock issue treat and remove them from the system to drier feed areas, if possible. Try to reduce poaching through high footfall areas such as field gateways to keep feet dry and healthy.

Having a handling area set up close by is advisable to assist with any treatments that may be required.

Choosing the Site

Not every option for outwintering is suitable for all farms and along with the system choice, field site is also important. Field sites on the farm should be chosen which meet the welfare needs of the animals and fulfill cross compliance requirements.



Figure 1: Overwintering field site showing key features when assessing a field for its suitability.

Water Supply and Requirements

Water must always be available for outwintered stock, even if stock are getting water from a wetter, lower dry matter crop as they still require additional water. A water trough with hard standing will reduce poaching and nutrient run off into watercourses. The requirement for water is influenced by the environmental temperature and the water content of the ration being fed.

Water intake required (l/kg of DM ingested)

Class of stock Livestock Class	Environmental temperature (°C)	
	<16 °C	16–20 °C
Calves	7.0	8.0
Beef cows & growing cattle	5.4	6.1
Ewes – mid pregnancy	3.3	4.1
Lambs	4.0	5.0

Table 1: Source: AFRC (1980). Note this is the total water allowance and includes water in the feed as well as water supplied.

Example:

Based on a growing 350kg steer grazing kale, at an average temperature <math><16^{\circ}\text{C}</math>:

- **Total dry matter intake = $350\text{kg} \times 0.02 = 7 \text{ kg dry matter/day}$**
- **Water requirement = $5.4 \times 7 = 38 \text{ litres of water/head/day}$**
- **Water supplied from kale at 70% of total intake = $4.9 \text{ kg DM at } 15\% \text{ DM} = 28 \text{ litres/day}$**
- **Water supplied from silage at 30% of total intake = $2.1 \text{ kg DM at } 35\% \text{ DM} = 3.9 \text{ litres/day}$**
- **Water required = $38 - (28+3.9) = 6.1 \text{ litres/day}$**

Note: Trough size and rate of filling should be checked to ensure these targets can be met.

There are excellent materials available on the Farming and Water Scotland website to assist with alternative watering of livestock (www.farmingandwaterscotland.org).



Figure 2: Bale grazing in Fife with a moveable water trough, which is emptied and dragged to next feeding area as required.

Shelter

In severe weather situations, animals will always choose to take shelter rather than to graze in the middle of a field. If the animals need to travel to find shelter, or there is no shelter provided, this will affect how the animals eat.

Natural shelter in the form of trees, hedgerows and earth banks will all provide some comfort to the stock, whilst artificial shelter options such as tall walls or an open-ended shed are good options if they are available.

If shelter is limiting, create shelter to provide protection from the weather, for example using straw bales or stacks of potato boxes situated in dry areas of the field.

Contingency Planning

Sometimes the weather turns which affects feeding or ground conditions and in these cases a contingency plan in any system is vital. Weather is out with our control and health and welfare of stock is paramount, not only for good farming practices but for allowing the stock to thrive. Without a contingency plan, cost savings of an outwintering system and animal welfare could be jeopardised.

Contingency thoughts:

- **Have additional stubble or grass fields that can be opened to allow stock onto them – ‘sacrifice fields’**
- **Option to lay out straw to provide a dry bed or have a shed/lean-to area in case of severe weather**
- **Essential to have run back areas for a dry lying area to give stock a break from the wet**
- **Areas to escape from the weather e.g. woodland**
- **Also think about feed areas, if conditions turn unfavourable**

In cases of extreme winter weather (heavy snow, very wet conditions or severe frost) alternative housing and feeding will be required. For these times, consider how to provide shelter and additional feeding to stock.

Mineral Supplementation in Outwintering Systems

The minerals supplied should complement the deficiencies in the crop that is offered to the animals.

For example, brassicas such as kale are low in iodine and contain goitrogens which interfere with iodine absorption, this interference increases iodine requirements 2–4 fold, therefore supplemental iodine is necessary.

There are numerous different approaches to outwintering livestock and the following sections aim to outline how to operate the systems in practice. This section will detail the set up and utilisation of the methods and not the establishment of them. The first crop covered is forage brassica and beet crops, continued by deferred grazing, bale grazing, all grass wintering, use of catch crops and winter grazing arable crops with sheep.

Placing Bales Prior to Winter

To avoid machinery on the fields in wet conditions, bales of wrapped forage (silage, hay or haylage) can be placed in the field in advance of winter and unwrapped and fed as required.

To understand how many bales to position in the field, a simple calculation can be performed as follows:
Step 1

		70kg ewe	400kg steer
A	Calculate animal requirement (animal weight x *predicted feed intake (section 2, table 5))	1.4kg DM	12kg DM
B	Daily requirement from forage is 30% (A x 30%) (70% from forage crop)	0.42kg DM	3.6kg DM
C	Estimated wastage 15% (B x 1.15)	0.48kg DM	4.1kg DM
D	Weight of bale	650kg	650kg
E	Dry matter of bale (from analysis)	30%	30%
F	Dry matter available in 1 bale (D x E/100)	195kg DM	195kg DM
G	Number of animals fed per bale (F / C)	406 ewes per day	47 steers per day

Table 2: Example of calculation to determine number of bales

***Predicted intake factors in higher energy requirement of outwintered livestock.**

Step 2: Measure the daily fence movements required, as per table 5. This is often 1.5–2m per day.

Step 3: Place the bales at the edge of the field to align with the daily breaks when ground conditions are favourable. If using a ring feeder, have one or two in the field to be placed over the top of the bale after it is unwrapped. Avoid placing bales where poaching damage is most likely, e.g. at bottom of slopes.



Figure 3: Analysed bales stacked showing highest quality for sheep.

It is highly recommended to analyse forage to understand the nutritional quality including dry matter, energy and protein so that the forage can be supplemented as required. Organising bales by different cuts or fields and taking an analysis from each stack gives you the knowledge of which bales are best quality. This allows for the best quality bales to be placed towards the end of the field to support increasing needs of some stock (e.g. pregnant ewes) or to account for any potential decrease in crop quality (e.g. loss of leaf on bulbs).

Section 2 – Forage Brassica and Beet Crops

Forage crops offer an excellent high yielding, quality, digestible feed alternative for outwintering livestock. They can be grazed throughout the winter period, or for part of the winter to reduce the housing period, filling the forage gap when grass growth slows down.

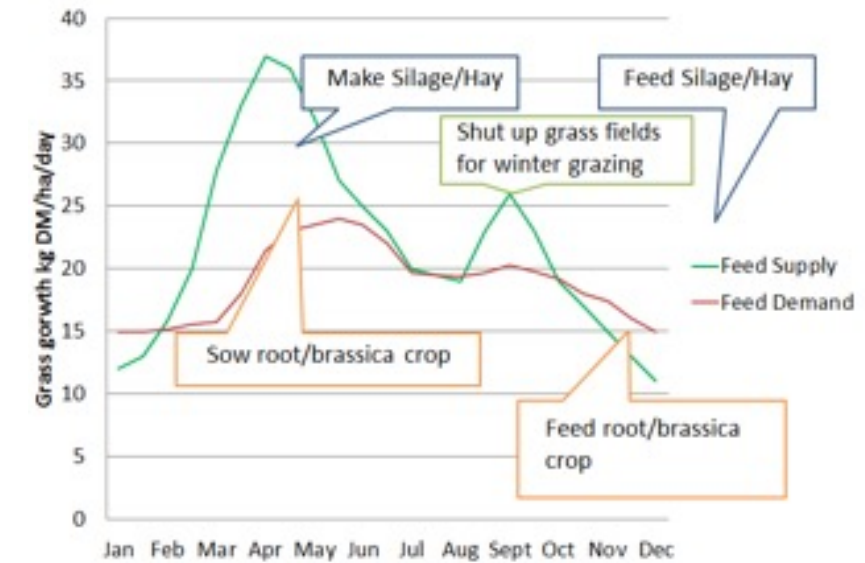


Figure 4: Example of a farm grass supply and demand curve with options to utilise feed surplus and deficit on a Scottish farm.

These crops offer a low-cost solution to rationing livestock throughout the winter period, while reducing the pressure on housing, labour and bedding costs. In addition to these advantages, there is also a benefit for the land in that forage crops are an excellent break crop for grassland renewal.

The forage crops can be grazed in situ, meaning there are also benefits to the ground in terms of increased organic matter and return of the grazed nutrients to the soil.

There are many brassica and beet crops now available on the market, which include leafy brassicas such as kale, root crops such as turnips and beet crops such as fodder beet. The leaves typically hold the protein and minerals, while the bulbs hold the energy. This is demonstrated overleaf in the nutritional value of the main forage crops grown.

Nutritional value of forage crops

	Fresh Yield (t/ha)	Dry Matter (%)	Crude Protein (%)	Metabolisable Energy (MJ/kg DM)	D Value (%)
Leafy Crops					
Kale	60-75	14-16	16-17	10-11	70-75
Rape & Hybrids	24-35	12-13	19-20	10-11	65
Root Crops					
Stubble Turnip	40-50	8-9	17-18	11	68-70
Swedes	70-90	10-13	10-11	13	82
Fodder Beet roots	65-80	10-20	6	13.2	80
Fodder beet tops	10-20	10-13	15-20	10.4	65

Table 3: Nutritional value of forage crops (Source FAS technical note TN733 Technical note (TN733): Forage Crops for Livestock | Information helping farmers in Scotland | Farm Advisory Service (fas.scot))

Suitability of Stock

Forage crops can be grazed by all ruminant stock classes. Animals should be condition scored prior to going on to a crop. Any leaner animals should be managed separately, until condition is regained. The condition of the stock should be monitored throughout the winter to ensure they are on target for their production cycle e.g. finishing lambs are gaining weight and suckler cows are maintaining weight.



Figure 5: Condition scoring ewe.

The dry matter of the crop demonstrates how much water is in the crop, the higher the dry matter the less water is in the crop, e.g. 20% dry matter fodder beet will have less water than a 9% stubble turnip. The higher the dry matter, the tougher the crop is for animals to eat. Understanding the dry matter of the crop, and which animals you graze the crop with should be taken into consideration e.g. cull ewes losing teeth may struggle to eat fodder beet bulbs.

Crop	Dry Matter %	Water %
Fodder Beet	20%	80%
Stubble Turnip	9%	91%

Table 4: Demonstration of dry matter % of crop.

The dry matter gives a good indication of how winter hardy the crop is e.g. a high dry matter crop would be more winter hardy than a low dry matter crop.

Utilising Forage Crops and Feed Allocation

Forage crops can be grazed in the field (in situ) or they can be harvested. When grazing in the field in situ, utilisation should be maximised to reduce wastage. This can be achieved by grazing the crop behind an electric wire. These should be long and narrow strips, which are moved frequently (cattle – daily), (sheep 3-4 days) to prevent trampling, reduce waste and allow for a balanced intake of protein and energy for the animals.



Figure 6: A long narrow electric fence to maximise forage crop utilisation.

For accurate planning and to maximise utilisation of the crop it is essential to measure the dry matter yield. The dry matter yield will vary depending on the variety, agronomy and geography. A simple yield assessment and calculation can be carried out to work out the dry matter yield and required daily allocation to the livestock; this forms the basis of how far to move the fence on a daily basis.

See appendix section for an example on calculating dry matter yield.

Feed Intake Predictions

After calculating the yield of the crop, you can then calculate how far to move the fence when giving the animals a clean break, which is ideally every day for cattle, and no longer than 3–4 days for sheep. The first step is to understand the animal's potential daily intake.

Stock Class	Dry Matter Allocation (% body weight)
Dry, mid pregnancy, late pregnancy, late lactation cows Dry, mid pregnancy, late pregnancy ewe Mature ram or bull	2
Finishing steers/heifers and replacements Early to mid-lactation cows and ewes	2.5
Growing cattle Early lactation ewes Flushing ewes and cows	3
Growing Lambs	4

Table 5: Feed intake predictions source: QMS Better Grazing.

An example of this would be a 70kg ewe, which would eat approximately 1.4kg dry matter per day or a 400kg growing heifer which would eat approximately 12kg dry matter per day.

Calculating Daily Allocation (adapted from AHDB)

		Example based on 300kg steer requiring 9kg DM/day
A	Estimated total dry matter intake (using 3% bodyweight)	9kg
B	Crop inclusion of the diet (allowing 30% fibrous forage)	70%
C	Daily requirement of forage crop (A x B)	6.3
D	Number of animals grazed	50
E	Daily requirement of forage crop (C x D)	315kg DM
F	*Estimated crop yield (DM/m ²) (crop yield 10.5 tonnes @70% utilisation) – 1.05kg/m ² x 0.7)	0.74 kg DM/m ²
G	Total Grazing Area Required/ Day (E/F)	426 m ² of brassica
H	Length of electric fence (feed face)	200m
I	Width of fence moved per day (G/H)	2.1 meters / day

Table 6: Example of a daily allocation calculation

*a table showing how to calculate the yield is shown in the appendix section

Transitioning Livestock

Forage crops should be gradually introduced to the animals to minimise digestive upsets. How the transition is designed depends on the crop that is grazed, with the transition to fodder beet being especially sensitive.

Transition to forage crops should allow animals to be introduced on a full stomach to prevent gorging, which can result in digestive upsets. The time the animals have access to the crop should be increased gradually, starting on grazing the crop for 1–2 hours at the start. The time can then be increased slowly until the animals have constant access to the crop.

For fodder beet the transition is more complex and should be timed over a three week period for cattle. For sheep this can be vastly reduced, given that they are selective eaters, choosing to eat grass verges along with the beet, slowing the transition of the crop naturally. For cattle the aim is to teach the animals to eat the beet. If they start too quickly they may get acidosis, which can in fact train them not to eat, given they will associate the beet with feeling sick. For cattle they should start at 1kg DM per animal per day (20t DM crop = every m² = 2kg of DM), and this should not be increased until all cattle are eating the bulbs readily. At this point, allocation can be increased by 1kg DM every two days until the animals start to leave it.

Having a wide headland (6–10 metres) aids transition greatly, as animals can transition at their own time, while having access to forage. Space for the animals to eat is very important during transition, where an allowance should be made of one metre of linear fence per cow or 0.30 metres linear fence per ewe.

Supplementation of Livestock Outwintered on Forage Brassicas

Ruminant animals have a requirement for fibre. Forage crops such as stubble turnips, kale, swedes and fodder beet are effectively concentrate feeds with low structural fibre. Brassicas and fodder beet are high in water soluble carbohydrates which ferment rapidly in the rumen; hence a slow transition and fibre are important to avoid acidosis or bloat.

Provide:

- **Supplementary forage such as straw, hay or silage,**
- **QMS Cattle Out-Wintering Systems booklet suggests for spring calving cows the diet should be made up of 50% brassicas and 50% straw on dry matter basis**
- **Rations are generally based on 70% brassicas to 30% forage – risk of overfeeding brassicas can lead to reduced intakes and performance. Health problems are related to iodine deficiency and anaemia.**
- **Bales should be placed during the summer to reduce the need for machinery to go into the field during the winter, minimising soil compaction and run-off from wheels.**

Root Crops Leaf to Bulb Ratio

- Good agronomy is important to maintain the leaf portion of root crops as table 2 and 6 show the leaf is a vital source of protein and minerals.
- Allocation is important particularly with sheep as they don't lift bulbs out of the ground like cattle.
- Over allocation will lead to sheep eating more protein rich leaf and leaving the bulb. This will result in negative energy balance and could lead to twin lamb disease or ketosis.
- Under allocation must also be avoided as forcing sheep to clear up the bulbs with no protein source will result in intakes dropping, leading to a drop in condition and smaller, weaker lambs at lambing time.
- If the leaf portion is lost e.g. to frost then stock will require supplementation either from high quality forage or concentrates.



Figure 7: Bales set up in forage crop field.

Performance

Growing Cattle

Growth rates of young stock are reported to be between 0.6–0.9 kg/day (AHDB). The quality of the forage fed alongside forage crops will impact animal performance therefore silage or good quality hay is preferential to straw. SAC's trial in winter 2005/6 out-wintering spring born steers on kale compared 3 groups of Limousin and Aberdeen Angus steers. Group 1 was fed kale and supplemented with straw, group 2 was fed kale and supplemented with silage and group 3 was a control group housed on slats. The control group performed slightly better over the 127 day period at an average 0.87 kg/day, compared to 0.74kg/day (kale + straw) and 0.76 kg/day (kale+silage). However, when they were then put to grass the kale groups demonstrated greater compensatory growth averaging 0.63kg/day compared to 0.55kg/day.

Finishing lambs

Growth rates have been reported up to 250g/day on forage crops and brassicas (AHDB) however, performance can be variable. Lambs on fodder beet do not grow as quickly, with daily liveweight gains of 100g/day being typical, unless concentrates are offered. Crop yield and efficiency of use will directly affect lamb growth rate. Soiling of crops can lead to rejection, which can reduce intake and performance.

Dry Cows and Ewes

The health and welfare of well managed out-wintered cows and ewes can be very good and in the right soil conditions they appear content and healthy. Due to the time they spend on their feet compared to housed stock, they tend to be in better condition resulting in easier calving/lambing. In SAC 2005 trials, only 3 out of 50 cows (6%) needed to be assisted at calving.

Anti-Nutritional Factors

Brassica crops contain glucosinolates which break down in the rumen to produce goitrogens. Goitrogens interfere with iodine absorption and inhibit thyroxine synthesis. They also contain high levels of antagonists, for example, brassicas are high in sulphur, an antagonist of copper. Most of the sulphur in brassicas is contained in the anti-nutritional factor; S-methylcysteine sulphoxide (SMCO) which causes damage to red blood cells and can lead to haemolytic anaemia.

Limiting the dry matter intake of brassicas reduces the risk; research by Nichol et al (2003) suggested diets of dry cows can safely contain 50–60% of the dry matter as kale, however in practice diets containing up to 70% of the animal's dry matter intake from kale have been successful.

Haemolytic anaemia is characterised by dark brown to red urine, pale or yellow mucous membranes and ill thrift. Some animals can collapse and suddenly die. If the disease is suspected animals should be removed from the crop and introduced to supplementary feed immediately.

Mineral Supplementation

There are many factors which can affect the mineral content of forage crops e.g. variety, climate, soil, leaf: bulb ratio. Therefore, taking a representative sample of the forage crop for mineral analysis will allow an accurate mineral plan to be made for a particular farm. In addition, blood analysis or a liver biopsy for copper and cobalt, is worth considering as evidence for a particular issue.

Mineral and vitamin supplements should always be available. Brassicas are generally high in calcium which can be an issue for cows and 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.

Brassicas are moderate to low status for magnesium, therefore dry cows will require supplementation. They are also low in trace elements selenium, iodine and copper, adding to the potential problems caused by the anti-nutritive compounds. The guideline levels are demonstrated in the appendix section along with the trace element contents. Soil particles will also contribute to the dry matter intake of livestock grazing forage crops, potentially inhibiting mineral and trace element availability.

Key Tips for Grazing Forage Crops

Cows

- **First calvers and older leaner cows are best to be excluded, to allow for tailored nutrition to their requirements**
- **Cattle should be fully ruminating and above 200kg liveweight prior to being on a forage crop**
- **Cattle should be moved off the forage crop slowly 3-4 weeks prior to calving, to ensure the rumen has time to adjust, while also offering greater hygiene to the new born calf**
- **Remove and treat any lame animals**
- **If the ground conditions are turning unfavourable, graze lighter store animals**
- **Ensure all animals are eating the crop. For any that are not eating, remove them and either house or offer a different form of nutrition**
- **Ensure clostridial vaccinations are up to date while grazing fodder beet**
- **If lifting bulb crops to feed, ensure they are cleaned thoroughly before mixing in a total mixed ration or offering to stock.**

Sheep

- **Remove and treat any lame sheep from the crop**
- **Ewes in late pregnancy rationed on root crops will require additional protein to ensure requirements are met e.g. excellent quality silage or concentrate**
- **Clip bellies of lambs before putting on brassicas to ensure lambs are clean for slaughter**
- **Ensure clostridial vaccinations are up to date while grazing fodder beet**

Section 3 – Deferred Grazing

Deferred grazing involves setting aside pasture in the summer and autumn to utilise for winter grazing. This system can shorten the length of the winter housing period and the associated costs (e.g. conserved forage, bedding, etc). It is best grazed early in the winter as reoccurring frost can lead to wastage of the grass. Deferred grass quality is equivalent to average hay – estimated to be around 9 megajoules of metabolisable energy (MJ ME) per kg dry matter (DM). There will be some wastage which may add to the soil organic matter. Deferred grazing is cheap, it avoids the cost of cutting and storage of conserved forage, but the low energy content means that it cannot sustain a heavy stocking density through the winter.

This form of overwintering is not suitable for lean cows and it is not suitable on heavy soil types. When choosing the class of stock, it is very important to think about their nutritional requirements, and ensure these are being met. All grass wintering is often the term referred to for sheep in deferred grazing and this will be discussed in section 4.

Quantifying the available forage in kilograms of dry matter per hectare (kg DM/ha) allows the grass to be rationed to the cattle, reducing wastage while maintaining high health and welfare of the animals.

The ideal cover for putting cattle on to deferred grazing is 3,250 – 3,500 kg of dry matter per hectare (over 15cm). If the deferred grazed area is required early spring in the following year, target a tight residual (short grass left behind) to improve pasture quality, this may require two rounds of grazing.

The kg of dry matter can be estimated using a calibrated sward stick, which converts grass height to kg of dry matter per hectare, or by using a plate meter. A good general rule of thumb for pasture rested from early summer, is four acres (1.6ha), per cow required to last the winter (November-March).

Grass quality and quantity reduces throughout the winter, meaning the animals may need supplemented in December/January, to ensure the animals' feed demands continue to be met. This is only possible if the ground conditions allow the animals to remain outside. Bales of forage can be placed prior to the winter to minimise damage to the soil from machinery, and a ring feeder can be placed over these bales as access is given to the animals.

The grass quality available is dependent on the species of grass within the sward. Species such as tall fescue, cocksfoot and perennial ryegrass will produce more autumn and winter growth than other species.

Grass Height (cm)	Kg DM/ha (summer)	
15	3930	Excessively High Covers
14	3740	
13	3550	
12	3350	
11	3150	
10	2960	Grazed
9	2750	
8	2540	
7	2330	Let it Grow
6	2110	
5	1880	
4	1650	
3	1400	
2	1120	
1	800	

Figure 8: Calibrated sward stick.

Rest Period

The longer the rest period, the higher the dry matter yield, however, the quality will be poorer and therefore more suited to stock with low energy demand e.g. dry cows.

Pasture with a shorter rest period will have more high quality, young leafy material, more suited to younger, growing stock. However, this will not have such a high yield of dry matter.

Strip grazing deferred grass behind an electric wire helps to extend the forage supply for longer than continuous grazing.

Deferred grazing of cattle is more suited to drier areas, as higher winter rainfall reduces the grass utilisation.

Supplementation

It is essential to monitor cow condition and avoid excessive loss of condition by using supplementation. Supplementation can include forage, concentrates or blocks/licks. The supplement will depend on the quality and quantity of forage. If providing supplementation in the deferred grazing area is not possible, the cows must be removed in the weeks leading up to calving.

Depending on grass availability, weather and cow condition, in calf cows may require additional feed (silage or concentrates) to allow them to remain on the deferred grazing and continue to meet the increased demands of the unborn calf.

Mineral and vitamin supplementation will be required in a deferred grazing system, especially on hill pastures that tend to have poorer soil nutrient status. These hill pastures tend to be deficient in certain trace elements (copper, cobalt and selenium).

Health Risks

There can be a tick risk (Tick-borne fever) with outwintering cows on deferred hill grazing if the cattle have not been on hill ground before, and are not acclimatised to hill conditions.

This tick-borne fever can often result in embryonic losses and abortion. It is important to be aware of the various risks and to discuss the potential control strategies with a local vet.

One method to acclimatise breeding stock, is to graze the hill areas with heifers in early summer so they can build up some immunity as youngsters before they are in calf. It is essential with outwintering cattle that there is a contingency plan if the winter conditions are particularly harsh e.g. prolonged snow in terms of additional feed being supplied to the cattle.



Figure 9: Dry suckler cows on deferred grazing Source: P. Frater, SAC Consulting.

Section 4 – All Grass Wintering

All grass wintering is a form of rotational grazing which aims to meet the pregnant ewe flock demand with grass alone over winter typically at around 10–11 ewes/ha. The sheep are moved every 1–3 days through electric fenced paddocks to ration grazed grass.

By rotationally grazing the grass rather than set stocking, utilisation of the grass is increased, resulting in less wastage of the grass and less supplementary feeding. In addition, rationing grass in this way gives better control over ewe intake and condition,

Grazing swards tightly in the winter removes dead material, distributes dung and reduces weed populations, which ensures better quality grass growth in the spring.

This system may not suit farms in certain areas as it requires grass growth throughout the winter. It is most suited to:

- well drained soils
- hardy breeds
- large groups



Figure 10: Sheep grazing in an All Grass Wintering System Source: P. Frater, SAC Consulting.

Planning All Grass Wintering

The fields should be closed off in the late summer or early autumn, to build up a feed supply for the winter. A few weeks prior to the intended start date of winter grazing, the fields should be measured for grass cover in kg of dry matter per hectare. This can be carried out using a calibrated sward stick (estimates the kilograms of dry matter (kg DM) in a field) or a plate meter. The grass cover should average 2,000–2,500kg dry matter/ha (over 7cm) before the winter grazing starts. Often the start date is three weeks after tupping, finishing two to three weeks pre lambing (105–110 days).

The best lambing fields should be grazed first, to allow the maximum rest period for the pasture. Fields are only grazed once during the winter, and paddocks are created using electric fencing ahead of time.

Setting up Paddocks

Step 1 – calculate the flock requirement

70kg ewe will eat 2% of her body weight = 1.40kg dry matter per day. A flock of 550 ewes would require 770kg dry matter per day.

Step 2 – measure the grass and deduct the target residual (how much is left behind)

Example feed available		Kg DM/ha
A	Field Measure	2,500
B	Target residual	900
C	Utilisation	80%
D	Available to graze	1,280
E	Field size	3ha
F	Total Grass Available (C x D)	3,840

Table 7: Example of calculating how much feed is available.

Target Residual	
Before Scanning	900kg DM/ha
After scanning	1,200kg DM/ha

Table 8: Target residuals of grass for all grass wintering paddocks.

Step 3: calculate days of grazing available in the field

Pre-scanning: 3,840 kg DM available ÷ 770 kg DM/day = 5 days of grazing

Post-scanning: 3,120 kg DM available ÷ 770 kg DM/day = 4 days of grazing

Step 4: Split the field depending on how often a shift is required, while maintaining a practical paddock size

Shifting frequency (pre scanning)	Number of paddocks	Paddock size
Daily	6	0.4 ha (1 acre)
2 days	3	1 ha (2.5 acre)
3 days	2	1.3 ha (3 acre)

Table 9: Example of shifting frequency.

The more frequently the flock is moved, the higher the utilisation of the grass. For paddock moves over 3 days, utilization should be reduced to 70%.

Contingency Planning

A backup plan is always required; keep silage or hay in reserve in case of poor weather such as snow or frost covering the ground.

Having a 'sacrifice' field which can be used in wet weather to avoid poaching the most productive fields is one strategy. Another would be to house stock, however, if stock must be brought inside, diet changes should be gradual to avoid any upsets to the rumen.

Good stockmanship is required to ensure the ewes continue to eat enough and regular monitoring of body condition score is essential. Ewes that are to be grazed need their feet and teeth checked and any ewes below a BCS of 2 should not be put on this system.

Electric Fencing

- Set up paddocks ahead of grazing to make movements less time consuming.
- Use a three-strand set up using an ATV – based fencer to speed up the process (see picture below)
- Move sheep at the same time each day



Section 5 – Bale Grazing

Bale grazing is a method of out-wintering suitable mainly for dry suckler cows. The system requires careful planning and organisation, placing the silage or hay bales out in advance of winter to avoid trafficking on the fields in wet conditions. Key points to setting up a bale grazing system:

1. **Select a suitable site** – Selecting a dry field will reduce the risk of nutrient loss to the environment from leaching and run-off. Ideally selecting a free-draining field will dry out better throughout the winter, benefiting both stock and soil. Livestock should be taken off the site in the later part of summer, building up a big cover of grass. Cattle on large covers of grass ensures minimal damage to the soil, even on wet days.
2. **Fencing** – Good electric infrastructure is required. A single electric wire is generally sufficient but make sure the voltage is high and the system is reliable. Note that snow is a good insulator; if there is a lot of snow a single wire may not produce an effective electrical current, therefore you may wish to consider using an extra lead wire for the fence or use a double wire.
3. **Plan and prepare** – set bales out in the summer to avoid the need for heavy machinery when conditions deteriorate. Ideally set up several fences at once, for example if you set up a weeks' worth of paddocks on the same day each week cattle can be moved and fed in a matter of minutes each day for the remainder of the week.
4. **Have a plan B** – if weather becomes particularly challenging having a fall-back plan is very useful.

Setting Up Bale Grazing

Step 1: Estimate livestock daily dry matter intake, using section 2, table 5

Step 2: Calculate bale requirement:

Example based on 700kg beef cow		
A	+Predicted total dry matter intake from Section 2, Table 5 (using 2% bodyweight)	14
B	Estimated intake from bales* 80%	11
C	Estimated wastage around 15% (therefore multiple B by 1.15)	13
D	Number of animals fed	20
E	Feeding period (number of days)	100
F	Total dry matter feed requirement (C x D x E)	26,000kg DM
G	Dry matter of bales (through hay/silage analysis)	35 %
H	Total feed requirement (fresh weight) (F/(100/G))	75,000kg
I	Weight of bale	700 kg
J	Bales needed (H/I)	110

Table 10: calculation for setting up bale grazing.

*Intakes will vary depending on grass availability between 0–30% of dry matter intake

+Predicted intake factors in higher energy requirement of outwintered livestock

Tip: utilise the forage analysis information. It is often better to place the higher quality bales towards the end of the field to support increasing requirements in later pregnancy.

Bale grazing case study – SRUC Barony



Figure 11: Bale grazing at SRUC Barony Farm.

SRUC Farms – Barony Farm, Dumfriesshire

Area used for bale grazing in 2021/22 – 36 hectares in total which included 7 hectares that had the bales placed on it and the remaining area was run back for the cattle.

Field Type – heavy clay. North facing, sloping fields that had either hedgerows or established woodland to provide shelter in windy and rainy conditions.

Establishment – Previous crop – spring wheat with Italian ryegrass seed broadcast mid to late April. The fields were either harvested as wholecrop or combined. A late dressing of 30kg N/ha was applied late September.

Bale set up – 120 bales were set out 5 metres apart in 4 rows with 4 ring feeders.

The aim was to graze from the top of the field to the bottom to avoid run off and excessive soil damage.

A two-fence system was set up (as can be seen in the picture to the right).

Cattle – 54 replacement in calf dairy heifers were put on the fields on 1st December 2021 and removed 2nd March 2022. These heifers weighed on average 400kg when they went to the bale grazing and gained an average of 0.7kg/day.

Feeding – The fence was moved every second day (dependent on the silage being consumed). This took approximately one hour to remove the plastic wrap from the silage, roll the feed ring onto the newly opened bales, move the fence to allow the heifers onto the new area and check the cattle. The silage used this year was bales weighing 650kg at 45%DM.

When the plastic was removed from the silage, a plastic disc was left on the bottom, which was collected when the fence and ring feeders were next moved.



Figure 12: Bale grazing in practice at SRUC Barony Farm.



Figure 13: Bale with plastic removed.



Picture 14: In calf heifers grazing the bale grazing at SRUC Barony Farm.

Top tips from Barony –

1. If possible, lay out bales in field earlier than later to avoid damage to field from machinery.
2. Silage needs to be very good quality as it is the main feed source to these heifers, with the grass secondary to the silage.
3. Ensure adequate shelter is available for the cattle in the form of hedgerows or woodlands.
4. Set aside adequate time to move fences, collect plastic and check animals. Although bale grazing is a cost saving on winter housing, it is not time saving and so a level of commitment is required.
5. If field conditions get very wet, consider opening up additional run off areas in the form of stubble fields or even next year's silage ground.

Section 6 – Winter Grazing of Arable Crops

Grazing sheep on winter cereal crops is a further option that can be used to fill the forage gap throughout the autumn and winter. Additional benefits of grazing winter cereals includes the option of sowing cereal crops earlier and using sheep as a management tool to control the crop growth throughout the winter. Grazing also has the potential to reduce disease in cereal crops, through the removal of diseased leaves.

This option may be attractive to some arable farmers who do not have livestock to increase the soil organic matter. It potentially gives an opportunity for neighboring farmers or new entrants to collaborate by supplying sheep and electric fencing to graze winter crops.

Choice of Crops

When choosing which crops to graze, look to the early maturing varieties first, and the more forward crops. These will benefit from grazing for disease control and to reduce the canopy throughout the winter.

The aim is to graze the crop while it is tillering (growth stage 21-29) and not into stem extension (growth stage 30), at which point there is a risk of reducing the yield through damage to the ear. The sheep can be grazed behind an electric wire on a paddock based system. It is important to monitor the grazing, and to move the sheep onto the next break when the required level of grazing has been carried out.



Photo 15: Grazed winter barley showing regrowth (photo credit Zach Reilly, SAC Consulting)

Trial work for Grazing Winter Cereals

Funding from the EU Horizon 2020 MIXED project, allowed SRUC to run a series of replicated grazing trials at SRUC's Craibstone Farm, Aberdeen, alongside monitoring of grazed commercial crops in 2020/21.

SRUC used two grazing densities, alongside a set of control plots to investigate the impact sheep can have on cereal crops. The grazed and ungrazed crops were monitored throughout the growing season including tiller counts, weed scoring, disease levels, ear numbers, grains per ears and final yield. The only consistent difference found between the grazed and ungrazed parts of fields was that the height of the crop was between 3 and 5cm shorter where the sheep had been grazed.

In terms of nutritional quality, the grazing trial on one commercial farm was assessed prior to grazing and a winter wheat crop had 1,600kg DM/ha, with a crude protein of 335g/kg DM (33.5%) and a metabolizable energy of 9.9 MJ/kg DM. Although this isn't a lot of feed compared to a grass field, using a mob grazing strategy, moving quickly across fields have worked well in practice. It has been found that cereals can be grazed quite hard, leaving minimal residual forage and the cereal crops still bounce back.

This research is ongoing, with funding being sourced through the EU Horizon 2020 MIXED project for a total of three years trials. One year of data has so far been collated.

Case Study – Farming for a Better Climate (Soil Regenerative Agriculture Group – Farming for a Better Climate)

One producer decided to graze his winter barley and winter wheat on the 18th of November 2021 he fenced a field of each cereal and put sheep on both crops. The eight hectare wheat field had 337 sheep grazing, and the 13 hectare winter barley field had 245 sheep grazing. The sheep grazed these until the 6th of December, when they were moved to graze cover crops.

The producer found that both cereals grew away from the grazing. He used temporary electric fencing, powered by a battery to keep the sheep in as the arable fields are without permanent fencing. However, due to the awkward shape of some of the fields, occasional wooden posts were used to change the direction of the fence and keep the wires tight.



Photo 16: grazed winter wheat showing regrowth (photo credit Zach Reilly, SAC Consulting).

Section 7 – Catch Crops

Catch crops, which are often also called cover crops offer an excellent method for providing quality nutrition in the autumn and winter to livestock, reducing the requirement for purchased feeds, while also benefitting the soil. These catch crops are best sown after a crop of winter barley, cut of silage or before reseeding grass.

This option may be attractive to some arable farmers who do not have livestock, to increase the soil organic matter, soil structure and break the cycle for disease and pests. It potentially gives an opportunity for neighboring farmers or new entrants to collaborate by supplying sheep and electric fencing to graze winter crops.

Choice of Crop

There are numerous crops on the market which are quick growing, and require very little establishment cost. These include forage rape, stubble turnips, kale, brassica mixes, Italian ryegrass, phacelia, mustard, oilseed radish and vetch to name a few. Often people choose to sow a mix of crops, with a selection of different attributes, e.g. quick growing, frost hardy, late maturing, etc. to ensure minimize risk of crop failure depending on winter weather conditions.

Crop Establishment

Having moisture in the soil to allow germination is key for the success of establishing catch crops. The seedbed should be prepared with minimal disturbance to allow for maximum moisture retention. There are various methods of establishment available, the typical route is to sow the crop as soon as the straw or silage is removed from the field through direct drilling. Another method would be to drill into a standing crop (see example below).

Case Study – SRUC Easter Howgate Farm

In summer 2020, stubble turnips were broadcast into standing winter barley on the 28th July, 10 days prior to the crop being harvested as whole crop. The seed was broadcast over the standing crop, meaning there were no cultivations or disruption to the soil. The standing crop meant that all dew and rainfall created a damp microclimate in the seedbed for the catch crop. The barley was harvested on the 8th August, at which stage the stubble turnips were at cotyledon stage. Once the barley was removed, the stubble turnips grew quickly with the access of light.



Figure 17: Catch crop stubble turnips at Easter Howgate September 2020.

This crop was grazed from the 28th September with finishing lambs, followed by ewes until Christmas.

There are a group of farmers who are experimenting with farm based trials on catch crop mixtures, methods of grazing and routes to terminate the crops. Information can be found at [Soil Regenerative Agriculture Group – Farming for a Better Climate](#)

Section 8 – Troubleshooting

Issues can arise during the winter when outwintering; this maybe management, health or problems out with your control e.g. weather. The main issues that commonly occur are discussed below.

Weather changes

Throughout the winter the weather can change very quickly, and the ground can become damaged from livestock, as well as the animals not having a clean dry place to lie. It is imperative to have a contingency plan in place when out wintering livestock. Examples of this may be housing, moving to a grass field or providing clean straw in the field as bedding.

Choke

This can occur when animals are eating small bulb crops (4–8cm). These small bulbs occur when either:

- the crop is being grazed too early
- it has been sown too late / poor establishment / poor yields

If the bulbs are smaller, the risk of choking can be reduced by ensuring the cattle are fed hay / silage / straw before they are shifted onto a new break to discourage hungry cattle from gorging the crop.

Animals not eating the crop

If animals are not eating the crop that has been offered to them, it may be due to the crops not being presented clean e.g. bulbs are dirty which is most often due to the break being offered being too large.

Another reason may be that the transition onto the crop was not suffice, and the animals have not learned how to eat the crop, which is particularly the case with bulb crops.

Finally, it may be that the crop has been under agronomic stress and may not have a large volume of leaf, which the animals like to eat. The variety of the crop will also have an effect, where a high dry matter variety may be too hard for the stock to eat.

Rumen Acidosis

Acidosis is the result of excessive accumulation of short chain volatile fatty acids produced by carbohydrate fermentation. This leads to a lower pH in the rumen which then favours the growth of lactic acid producing bacteria, exacerbating the problem.

Acidosis is caused by the ingestion of too much feed high in rapidly fermentable carbohydrates, or when there is not enough physical fibre in the ration. Acidosis most often occurs when the transition onto a highly fermentable feed such as fodder beet is not managed well, or if animals break through the fence and gorge themselves on the crop.

Generally, sheep are much less susceptible to acidosis on fodder beet as they regulate their intake better than cattle.

Cattle that are showing signs of acidosis may exhibit reduced feed intake, not thriving, lameness or going off their feet, diarrhoea and in severe cases sporadic deaths. Work by Professor Jim Gibbs in New Zealand found that in cases of poor transition onto fodder beet only around 5% of the herd will present as severe with another 5–10% as wobbly on their feet but still walking.

Treatment will depend on the severity of the case. Work from New Zealand found in mild cases cattle will generally slow their eating, therefore preventing the condition from becoming more severe. In these mild cases, removing cattle from the crop to help restore rumen pH is not necessary, but reduce the allocation of the forage crop by 75% for 2–3 days to allow full recovery and then begin slowly increasing the proportion of forage crop in their ration.

In severe cases animals should be removed from the crop and fed alternative forage such as silage or hay. Only when they have fully recovered can animals be moved back to the forage crop but the transition will have to be started from the beginning.

Flowering Crops

Flowering forage crops cause a concern for animal health due to their SMCOs (anaemia causing compounds). If crops are flowering then animals should not graze them. Options in this scenario would be to top the flowers off with a topper, which would stop them eating the flowers. Another option would be to offer animals less e.g. 30% of their dry matter of the crop.



Figure 18: Flowering forage crops, not suitable for animals grazing.

Additional Potential Health Problems

There are a series of additional health problems that may occur, although these are rare. If health problems arise, speaking to a vet and a nutritionist would be advised.

Nitrate poisoning – caused by fast growing crops in soils with high Nitrate levels. Cool overcast weather and high N fertiliser use can increase the risk. Symptoms include, abdominal pain, weakness, scour, drooling, muscle tremors, can cause death. To assist with the treatment, animals should be removed from the crop and feed high quality forage. To prevent transition stock onto crop slowly and avoid the use of high N fertilizer.

Kale anaemia (redwater) – caused by excess levels of amino acid compound S-methyl cysteine sulphoxide (SMCO). SMCO levels tend to be higher when soil phosphate levels are low, and nitrogen and sulphur levels are high. Symptoms include, red urine (especially in animals grazing kale), weakness, and reduced appetite. To assist with the treatment, animals should be removed from the crop. To prevent test soils to apply suitable fertilisers. Avoid fertilisers with sulphur unless results show it is required. Ensure diet has adequate levels of selenium and copper.

Bloat – caused by brassicas which are quickly digested in the rumen. Symptoms include, a distended left abdomen, pain, discomfort, in extreme cases death. To assist with the treatment, pass a stomach tube to release the gas or a trochar into the side of the rumen. To prevent feed fibre alongside the crop (straw / hay / silage) and transition the stock onto the crop gradually.

Photosensitisation – caused by compounds in the brassicas resulting in skin becoming sensitive to sunlight. More common in rape and kale. Usually when crop is grazed too young and is still growing. Symptoms include, peeling skin, hair loss, reddening, ulceration of the skin, crusting and bleeding. To assist with the treatment, remove stock from the crop. To prevent ensure stock are only put onto crops that are at the correct growth stage (maturity).

Iodine deficiency – caused by brassicas (especially root crops) which contain glucosinolates that block the uptake of iodine from the diet. Brassicas are also low in iodine and therefore increase the risk of iodine deficiency. Symptoms may result in a swollen thyroid. In pregnant animals it can increase the number of stillbirths. Iodine deficiency can also affect fertility. To assist with treatment remove stock and treat with an iodine supplement. To prevent, consider bolusing animals prior to grazing crops and avoid grazing pregnant animals.

Staggers – caused by a low content of magnesium in forage crops. Symptoms include dullness, stiffness in body, seizures, sudden death. Prompt treatment can be made with magnesium products. To prevent supplement cows whilst grazing the crop to ensure they are receiving enough magnesium.

Clostridial diseases – Fodder beet can increase the chance of clostridial disease infections due to the high sugar load in the intestines. Symptoms include, weakness, collapse, and sudden death. To prevent ensure cattle and sheep are vaccinated prior to transitioning onto the crop. Remember annual booster vaccinations.

Feet issues – caused by wet, muddy conditions can increase the risk of foot infections and lameness. Symptoms include, non-weight bearing on all feet resulting in loss of condition. Treatment includes, removing affected stock and treating immediately. Prevention of feet issues includes having adequate dry areas to lie on and keeping the feet as dry and clean as possible. Foot trimming cattle prior to outwintering.

Section 9 – Farmer Tried and Tested Tips

Tip 1: Use of bungy at the end of the wire makes moving the fence a one person job and saves letting the wire out and winding it back in. It allows you to easily lift the fence over the bales to the next break and the wire tightens back up.



Figure 19: Electric wire on a bungy.

Tip 2: Use of live posts; the fence posts are live meaning the tops are uninsulated. This prevents stock pushing the posts over and getting under the wire.

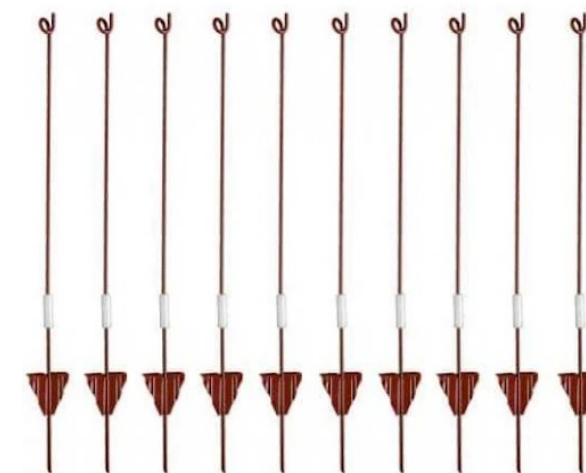


Figure 20: Live wire posts.

Tip 3: Use of electric insulated gloves allowing you to work with the electric fence and posts, offering a saving of time.



Figure 21: Insulated gloves

Tip 4: Using two wires placed forward, preventing break outs. If cattle get through to the next break they can't gorge/trample the whole field.



Figure 22: Use of two wires.

Tip 5: Use of a back fence to prevent poaching.

Tip 6: Each wire has its own circuit so if one fuses/ battery dies they are not all affected.

Appendix Section

Measuring dry matter of a forage crop

To calculate the dry matter yield of leafy brassicas and broadcast root crops is slightly different to root and beet crops planted in drills. The kit required for both methods is the same and includes the following:

Kit required:

- 1m square quadrat or 2.66m of alkathene pipe in a loop (this calculates to 0.5m²)
- a bag, such as a grass seed bag
- pair of shears or knife
- set of hand-held scales
- note pad and pen

The two examples below demonstrate these methods.

Method 1 – leafy brassicas and broadcast root crops

Step 1: Place the quadrat on a representative area of the field (avoiding end rigs, poor yielding patches, etc.) If using the alkathene pipe method place over two areas to allow for a square metre reading. Another method would be to use plastic electric fence posts, where the plastic stick is often 1m length.

Step 2: For root crops, lift all roots (removing dirt) and leaves from within the area. For leafy crops, cut 1 inch from the ground within the area and place in the bag.

Step 3: Weigh bag using the scale.

Step 4: Multiply the weight by 10,000 giving the fresh weight per hectare.

Step 5: Multiply the result by the estimated dry matter of the crop (e.g. hybrid brassica 12%) and divide by 100 to calculate the dry matter per hectare.

A	Total bag weight	7kg fresh weight
B	Fresh weight per hectare (A x 10,000)	70,000kg FW/ha
C	Estimated dry matter (B x 12%)	8,400kg dry matter
D	Tonnes of dry matter per hectare (C / 1,000)	8.4 tonnes dry matter

Using the dry matter yield a daily allocation can be calculated depending on the stock class grazing the crop.

Method 2 – root and beet crops in drills

For this method, it is essential to know what your row width is, for example, if it is 45cm, measure 5.5 metres along a drill, if it is 50cm, measure 5 metres along the drill, to allow for 25m sq.

Step 1: Measure along the row (as above) in a random sampling area, avoiding end riggs, running a tape measure 5m along the drill in a 50cm drill width.

Step 2: Lift the whole plant (bulb and leaf) from both sides of the 5m, lifting 2 rows of root at either 5m (or 5.5 metres length – depending on row width)

Step 3: Use a knife to separate the leaf and bulb.

Step 4: Weigh the leaf and bulb separately; ensuring all brown, slimy leaves are included in the measurement for the leaves.

Step 5: Repeat over the field (5 x sampling areas of 5m x 1m = 25sqm)

Once you have the measurements you can very quickly convert the fresh weight into dry matter per hectare as shown below. Book values for dry matter can be used, but dry matter yields vary hugely between varieties and the agronomy of the crops. Forage analysis labs can analyse the dry matter of the crop quickly, giving you a deeper insight to the yield of the crop and this would be advised to increase accuracy.

		Bulb	Leaf
A	Sample 1 Sample 2 Sample 3 Sample 4 Sample 5 Total Fresh Weight (FW)	40 kg 45 kg 48 kg 42 kg 40 kg 215 kg	21 kg 22 kg 23 kg 24 kg 23 kg 113 kg
B	Tonnes Fresh Weight / ha A x 400 / 1000	86	45.2
C	Dry Matter (%)	15%	10%
D	Tonnes Dry Matter/ ha (B x C)	12.90	4.52
E	Tonnes Dry Matter Yield (D bulb + D leaf)	17.42 tonnes / ha	

Mineral and Trace Element contents and requirements

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 1: Major minerals contents in brassica and fodder beet (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

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

- 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 Prof. 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

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

Animal	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

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

- 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

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