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Forage Crops for Livestock

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Summary

- **Forage crops offer a high yielding high quality food stuff to feed to livestock in months were grass growth is limited. There are two types of fodder crop, leafy plants and those with bulbs.**
- **After assessing the suitability of the site to grow the crop (slope, soil type, shelter, etc.), understanding the length of time the crop takes to grow, and what the end use of the crop is, provide the initial steps in deciding which forage crop to plant.**
- **Forage crops offer a least cost source of winter feed for livestock with a high level of nutritious qualities.**

Why Grow Forage Crops for Livestock?

Forage crops offer an excellent solution to filling the forage gap in the autumn and winter months when grass growth slows down. They integrate well with grassland and livestock, aiding in controlling a surplus of spring and summer grass and offering a high yielding, quality feed for the autumn and winter months. 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.

What Crops are Available?

There are numerous forage crops available, each crop has its own strengths and weaknesses, and these should be compared to your own situation and requirements. When working out which crop to grow, look at the length of time it takes to grow before it can be eaten (utilised) by livestock, think about how winter hardy it is, what class of livestock will be eating the crop, if the plan is to feed in situ in the field or to lift the crop, etc.

The different crops available, and the time to sow and utilise them are shown below.

Table 1: Forage crops seasonality of sowing and utilisation

Crop	Sowing	Utilisation
Kale	April – June	October – March
Rape and Hybrids	May – August	October - December
Swedes	April – June	October - March
Stubble Turnips	April – August	September - February
Fodder Beet	March – early May	October - March

This shows that the quick growing fodder crops include stubble turnips (utilise 8-13 weeks), forage rape and hybrid brassica (utilise 10-12 weeks). The slower growing crops include kale (utilise 22-30 weeks), swedes and fodder beet (utilise 25-30 weeks).

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The slower growing crops suit being sown in the spring months and utilised in the autumn and winter. Whereas the fast growing crops suit being sown in either the spring or as a catch crop following cereal crop.

The different crops suit different situations, have different growth patterns, different strengths and nutritious qualities.

Table 2: Qualities of different forage crops

Fodder Crop	Qualities of the Crop
Leafy Crop	
Kale	High yielding 8-10 tonnes DM/ha (60-70 tonnes/ha fresh) High cold tolerance Utilise into the winter High protein feed (16-17%), good energy 10-11 MJ/kg DM Growing cost ~£450/ha (£180/acre)
Rape and Hybrids	Yields 3.5-4 tonnes DM/ha (24-35 tonnes/ha fresh) Fast growing crop High protein feed (19-20%), good energy 10-11 MJ/kg DM Last well through the winter but not as cold tolerant as kale Potential for summer, autumn and winter grazing Growing cost ~£270/ha (£109/acre)
Root Crops	
Stubble Turnip	Yields 3.5-5 tonnes DM/ha (38-45 tonnes/ha fresh) Quick growing Suitable for main crop or catch crop Leaves hold the protein, bulbs hold the energy (11 MJ/kg DM) Low establishment cost ~ £320/ha (£130/acre)
Swedes	High yielding 7-10 tonnes DM/ha (70-90 tonnes/ha fresh) Protein 10-11%, high energy (13 MJ/kg DM) Growing cost ~£530/ha (£215/acre)
Fodder Beet	High yielding 15-17 tonnes DM/ha (80-90 tonnes/ha fresh) Protein 12-13% (combined leaf and bulb), High energy (13 MJ/kg DM) Palatable Growing cost ~£770/ha (£311/acre) More details can be found on the technical note specific to fodder beet at https://www.fas.scot/publication/tn694-alternative-forages-sheep-fodder-beet/

Nutritional Value

Table 3: Nutritional values of the forage crops

	Fresh Yield (t/ha)	Dry Matter (%)	Crude Protein (%)	D value	Metabolise Energy (MJ/kg DM)
Leafy Crops					
Kale	60-75	14-16	16-17	70-75	10-11
Rape & Hybrids	24-35	12-13	19-20	65	10-11
Root Crops					
Stubble Turnip	40-50	8-9	17-18	68-70	11
Swedes	70-90	10-13	10-11	82	13
Fodder Beet	80-100	15-23	12-13	78	12.5-13

Establishment and Growing Fodder Crops

Planning and Site Choice

The site choice is an extremely important aspect to growing and utilising a forage crop. In terms of growing the crop, a soil that is capable of being worked in to a fine seedbed is essential to allow optimal germination of the plant. For utilising the crop, the site should be able to stand up to extreme climatic conditions, provide shelter and water for grazing animals and not offer any environmental limitations such as poaching of water courses, etc.

The majority of forage crops can be grown on a wide variety of soils, ideally be a light to medium, free draining soil. The crop will be utilised in the winter, therefore consider shelter and water for the grazing livestock. Provide a water trough with hard standing to reduce the risk of poaching and nutrient run off into watercourses. A grass or stubble run back should be offered to the grazing animals, ideally this would involve a headland of 6-10 metres width surrounding the crop. This should be considered when selecting the site. If the aim is to lift the crop rather than graze it, good access for modern machinery will be required.

When selecting a site for the forage crop, think about the field history, for example has the field been in grass for a long period of time. If this is the case, it may benefit from such a crop, allowing a break crop between grass, giving the benefits from a deep rooting crop to aid in breaking up compaction, while also benefiting from the nutrients returned to the ground by the grazing livestock.

The field history will also involve looking back to understand when the field last grew a brassica crop (the family most forage crops belong to). There should be a 4-5 year break between brassica crops. This would involve forage crops such as swedes, kale, etc. or oilseeds. Please note fodder beet is not a brassica, but is instead, from the beet family.

Seedbed and Sowing

A fine, firm seed bed is required with no soil compaction problems. Ground preparations should create good soil conditions for establishment, reaching water and nutrients and full root development.
Weed infestations can be an issue for some growers, especially for crops following grass leys. In this case there is an option to use a stale seedbed, where the ground would be worked, and then left to allow any weeds to germinate. These would then be eradicated with a pre sowing herbicide, allowing the germinating forage crop a weed free seedbed.
There are sowing options depending on the crop of choice, including traditionally (plough, disc, roll and sow) or direct drilling, giving a firmer surface or even broadcasting seed, which is more of an option for catch crops. Seed rates are shown below for the different sowing methods for the different crops.

Table 4: Sowing rates and method of sowing

	Swedes	Kale	Forage Rape	Stubble Swedes	Fodder Beet
Sowing	April-June	April-early July	May-August	May-August	March-April
Precision Drill	350g-850g/ha	2kg/ha	-	-	
Direct Drill	3kg/ha	4-5kg/ha	6kg/ha	5kg/ha	100,000 seeds/ha
Broadcast	5kg/ha	8kg/ha	8kg/ha	7.5kg/ha	
Sowing Depth	1cm	1cm	1cm	1cm	2-3cm

The soil temperature should be at least 5^0C for sowing the forage crop seeds. If the ground is cooler, some of the plants can potentially bolt (fodder beet) in retaliation to the stress at establishment. These bolting plants are linked to the weather in the spring from when the seed is sown and for the next 40 days. Bolting occurs when temperatures are consistently below 12^oC. This 40 days of risk period for bolting plants is more likely in a long cold period than short periods of frost.

If drilling the seeds is delayed, there will be a degree of yield loss.

For forage crops with bulbs (swedes, fodder beet and stubble turnips), there is an option to drill these on the flat or on the ridge.

Table 5: Sowing bulb crops on the flat or on ridges

	Flat	Ridge
Advantage	- Least cost option	-Keep seedlings and young plants safe from flooding or drain water. - Raises the plant, avoiding any damage from tractors during passes such as post sowing fertiliser or herbicide application - More growing room for the plant
Disadvantage	- More chance of damaging plants with machinery passes - If high rainfall, plant more affected.	- Soil more prone to dry out with extra surface area exposed - Additional cost - ~£48 to ridge drills (machinery ring – Feb 2020)

Key Environmental Tips

- **Choose free draining soils with no steep slopes to minimise the risk of poaching and run off**
- **Ensure the field offers shelter for the grazing stock**
- **Ensure water is supplied to minimise poaching around watercourses**

Soil and Nutrient Management

Soil nutrients and fertiliser recommendations

Soil analysis should be carried out well in advance of planting to identify pH levels and the reserves of P_2O_5 (phosphate), K_2O (potash) and Mg (magnesium). The target pH for forage crops is dependent on crop requirement and soil type. Soil pH values can vary considerably metre by metre and liming should avoid leaving patches below pH 5.6 on mineral soils as soluble aluminium inhibits crop roots and reduces yield. Forage crops can be grown in a range of pH values from 5.8 to 6.5 with the majority of nutrients being more available in the pH range 6.0 to 6.2. Further details of liming materials and application rates to correct low pH values can be found in *Technical Note TN714: Liming materials and recommendations.*

To achieve the potential yields that forage crops offer, the plants must be supplied with adequate nutrients. Organic and inorganic fertilisers should be applied if there is a crop nutrient requirement based on soil analysis and at rates that will result in the maximum yield of crops of acceptable quality, whilst ensuring protection of the surrounding environment and complying with Nitrate Vulnerable Zone (NVZ) regulations if applicable.

Nitrogen (N), phosphate (P_2O_5) and potash (K_2O) recommendations are based on *Technical Note TN734 (2020): Fertiliser recommendations for vegetables, minority arable crops and bulbs*, and taking into account the latest guidance offered in regional *Technical Notes TN715 to TN718: Phosphate and potash recommendations for crops grown in Highland and Islands, South West Scotland, North East Scotland and Tayside, and, Fife, Lothian and Scottish Borders.* These are aimed at giving the best financial return for the producer whilst complying with NVZ rules and minimising losses to the environment. Reference to the technical notes are shown at the end of this note.

Nitrogen

Nitrogen can be applied by means of organic manures or inorganic fertilisers. Table 6 shows the total nitrogen recommendation for growing forage crops and Table 7 shows the nitrogen residue group from the previous crop. These tables should be used together to work out how much N is required.

Nitrogen can be applied twice to the crop, initially this is to the seed bed to aid establishment of the crop, often at a rate of 20 to 40 kg/ha at this stage. The remaining balance of nitrogen should be applied after the seedlings have established.

Table 6 – Nitrogen recommendations (kg/ha) for different crops including differences where soil type has an effect on the rates

Forage Crop	Nitrogen (N) (kg/ha)					
	Previous Crop/Grass Nitrogen Residue Group(see Table 7)					
	1	2	3	4	5	6
Fodder beet (Grazed or 85t/ha roots lifted)	130	120	110	90	60	0-40*
Swedes/turnips (Grazed or 65t/ha roots lifted)						
Sands/Shallow	120	100	90	70	40	0*
Sandy loam, Other mineral soils	120	100	80	50	20	0*
Humose	50	40	30	20	0*	0*
Peaty	20	20	0*	0*	0*	0*
Swedes/Stubble Turnips (grazed)[a.]						
Mineral soils	100	80	60	40	0 - 40	0*
Kale						
Sands/Shallow	180	170	160	140	110	70
Sandy loam, Other mineral soils	160	150	140	120	90	50
Humose	100	90	80	60	30	0*
Peaty	60	50	40	20	0*	0*
Forage Maize, Rape						
Sands/Shallow	140	130	120	100	70	30
Sandy loam, Other mineral soils	120	110	100	80	50	10
Humose	70	60	50	30	0*	0*
Peaty	40	30	20	0*	0*	0*
Hybrid Brassicas (grazed)[a.]						
Sands/Shallow	180	170	160	140	110	70
Sandy loam, Other mineral soils	160	150	140	120	90	50
Humose	100	90	80	60	30	0*
Peaty	60	50	40	20	0*	0*

*Up to 20 kg/ha of nitrogen may be needed where soil nitrogen supply is expected to be low initially, for example cold, wet conditions.

[a.] For catch crops reduce the nitrogen by 50% to 75% to account for shorter growing season.

Table 7 – Previous crop groups

Group	Previous Crop
1	spring barley, spring oats, spring rye, spring wheat, winter barley, winter oats, winter rye, winter wheat, whole crop, triticale, carrots, shopping swedes, turnips (human consumption), linseed, onions, asparagus, radish, narcissus, tulip, swedes/turnips (stockfeed), parsnips, ryegrass (seeds)
2	forage maize, forage rape, green manure crop, kale cut, winter oilseed rape, spring oilseed rape, hemp, courgette, beetroot (red baby, other), potatoes (<60 days, seed and punnets), potatoes (60-90 days, seed and punnets), potatoes (60-90 days, ware), potatoes (90-120 days), potatoes (>120 days), blackberries, loganberries, blackcurrants, redcurrants, blueberries, tayberries, strawberries, raspberries 1 – 2-year low N1 leys and not grazed within 2 months of ploughing out or during Sept./Oct
3	harvested fodder (root only), beans (broad), beans (dwarf/runner), beans (field vining), vining peas, combining peas, lupins, leeks, lettuce, rhubarb, uncropped 1 – 2-year low N leys and grazed within 2 months of ploughing out or during Sept./Oct. 1 – 2-year high N leys and not grazed within 2 months of ploughing out or during Sept./Oct. Thin, permanent grass, low N, no clover
4	grazed fodder, turnips grazed, kale grazed, forage rape grazed, chicory pure stand grazed 1 – 2-year high N leys and grazed within 2 months of ploughing out or during Sept./Oct. 3 – 5-year low N leys and not grazed within 2 months of ploughing out or during Sept./Oct. Thick, permanent grass, low N
5	leafy brassica vegetables, leafy non-brassica vegetables, brussels sprouts, cabbage (all types), calabrese (broccoli), cauliflower 3 – 5-year high N leys and not grazed within 2 months of ploughing out or during Sept./Oct. 3 – 5-year low N leys and grazed within 2 months of ploughing out or during Sept./Oct. Permanent grass, high N, not grazed within 2 months of ploughing out or during Sept./Oct.
6	3 – 5-year high N leys and grazed within 2 months of ploughing out Permanent grass, high N, grazed within 2 months of ploughing ou
Low N means less than 150 kg/ha/yr fertiliser N used on average in last 2 years. High N means more than 150 kg/ha/yr fertiliser N used on average in last 2 years or high clover content	

For example for fodder beet, if the previous crop was permanent grass with a low nitrogen content and no clover, the recommended rate of nitrogen would be 110 kg/ha (44 kg/acre).

In addition, adjustments for N can be made for soil type using Table 8 and excess winter rainfall using Table 9 See *TN734 (2020): Fertiliser recommendations for vegetables, minority arable crops and bulbs* for further information.

Table 8 – Adjustment to standard N recommendation for different soil types

	Soil Type		
Crop	Sands and shallow soils	Sandy loams & other mineral soils	Humose and peaty soils
Vegetable* and minority crops other than linseed, forage maize, forage rape, kale, shopping swedes, turnips (human consumption), swedes/turnips (stockfeed) and potatoes.	+ 10%	No Change	- 10%
* Vegetables are grown on sands but very rarely grown on shallow soils (less than 40 cm over rock)			

The drier the winter and the greater the soil capacity to hold water, the smaller the proportion of N from crop residues that will be washed out of the soil before crop growth starts in the Spring. If winter rainfall between 1 October and 1 March is more than 450 mm, then the standard N recommendations should be adjusted according to soil type and previous crop group using Table 9.

Table 9 – Adjustment to standard N recommendation following excessive winter rainfall (more than 450 mm) for different soil types and previous crop groups

	Winter Rainfall >450mm		
Crop	**Sands, sandy loams and shallow soils, previous crop group 2**	**Sands, sandy loams and shallow soils, previous crop groups 3 - 6**	**All other soils, previous groups 2 - 6**
All vegetable and minority crops	+ 10 kg/ha	+ 20 kg/ha	+ 10 kg/ha

Phosphate (P_2O_5)

Table 10 illustrates the phosphate requirements for forage crops where the soil is of Moderate P Status. Fodder crops can be responsive to phosphate so it is always best to ensure that the soil is at target status prior to sowing. Work has been carried out and published in *Technical Note 668 Managing Soil Phosphorus* showing that soil types have different rates to which they lock up phosphate, this is called their Phosphate Sorption Capacity (PSC). The PSC value of different soil associations have been allocated a PSC value of 1, 2 or 3, with 1 having the lowest sorption capacity and 3 having the highest value. Table 11 provides details of the additional phosphate required to be supplied to crops growing on Moderate soil P Status.

Table 10 – Phosphate Recommendations (kg P_2O_5/ha) for crops based on Moderate P Status

Crop	**Soil P Status**
	Moderate
Fodder beet (85t/ha roots lifted)	60
Fodder beet (grazed)	60
Swedes/turnips (65t/ha roots lifted)	46
Swedes/Stubble Turnips (grazed)	25
Kale (40 t/ha, cut)	50
Kale (grazed)	25
Forage Rape (grazed)	25
Hybrid Brassicas (grazed)	25

For further details see the *Technical Notes TN734 (2020): Fertiliser recommendations for vegetables, minority arable crops and bulbs*, and the latest guidance offered for P and K which also contain information on what the PSC is for the different soil associations within each region in the regional Technical Notes *TN715 to TN718: Phosphate and potash recommendations for crops grown in Highland and Islands, South West Scotland, North East Scotland and Tayside, and, Fife, Lothian and Scottish Borders.*

Table 11 – Effect of PSC on annual fertiliser adjustments (kg P_2O_5/ha) for fodder crops

P sorption capacity	**Soil P Status**				
	Very low (VL)	**Low (L)**	**Moderate (M-)**	**Moderate (M+)**	**High (H)**
PSC 1	+40	+20	0	-10	-20
PSC 2	+60	+30	0	-20	-30
PSC 3	+80	+40	+20	0	-40

Potash (K_2O)

Table 12 illustrates the potash requirements for forage crops based on the soil K status. If the crop has a high potash requirement this can be delivered through a mixture of organic and inorganic manure sources. The potash is required for numerous processes including nitrogen uptake, which affects the protein of the crop, water regulation and it is also required for the formation of sugars within the plant.

Table 12 – Potash Recommendations (kg K_2O/ha) for crops based on Moderate K Status

Crop	Soil K Status
	Moderate
Fodder beet (85/t/ha roots lifted)	340
Fodder beet (grazed)	150
Swedes/turnips (65t/ha roots lifted)	156
Swedes/Stubble Turnips (grazed)	50
Kale (cut 40t/ha)	200
Kale (grazed)	70
Forage Rape (grazed)	35
Hybrid Brassicas (grazed)	40

Table 13 provides details of the additional K required depending on the soil K Status at sowing.

Table 13 – Effect on soil K Status on annual fertiliser adjustments (kg/ha)

Crop	Soil K Status				
	Very Low (VL)	Low (L)	Moderate (M-)	Moderate (M+)	High (H)
Fodder crops	+60	+30	0	0	K offtake x 0.5

For further details see the Technical Notes *TN734 (2020): Fertiliser recommendations for vegetables, minority arable crops and bulbs*, and the latest guidance offered in regional Technical Notes *TN715 to TN718: Phosphate and potash recommendations for crops grown in Highland and Islands, South West Scotland, North East Scotland and Tayside, and, Fife, Lothian and Scottish Borders.*

Sodium (Na)

Sodium is not a key requirement for brassica crops. But beet crops such as fodder beet do require it. Fodder beet has been developed over time from cultivars such as wild beet and sea beet. These originated in the Mediterranean and grew in land with a high sodium (salt) content. Some soils in Scotland contain high levels of sodium, such as soils close to the coast, fen peats and silt, but most agricultural soils do not. For this reason, 200 kg/ha of Na_2O as agricultural salt is recommended to ensure that the desired growth and leaf expansion is achieved. Deeply cultivate the application into the soil prior to drilling.

Sulphur (S)

In situations where sulphur levels might be low, for example on light soils, following wet winters, where there has been no previous history of manure use or sulphur-containing fertilisers, use of sulphur-containing fertilisers should be considered as a base dressing to supply both N and S. In the situation described for brassica crops, apply up to 75 kg SO_3/ha (see Technical Note *TN685: Sulphur Recommendations for Crops).*

Magnesium (Mg)

Magnesium is an element that aids plant growth; forage crops are rapid growing plants that have a high requirement for the nutrient. If soil magnesium levels are Very Low (VL) or Low (L), apply magnesium (MgO) at 120 kg/ha where the Mg Status is VL and 80 kg/ha where the Mg Status is L (see Technical Note *TN714: Liming materials and recommendations)*. If lime is required to raise the pH, magnesium lime is a cost-effective option to achieve both purposes.

Boron (B)

Boron deficiency can cause huge losses in root crops and brassicas were symptoms initially show death at the growing point, moving to heart rot depending on crop species. Depending on soil type, soils may or may not contain a sufficient supply of boron and therefore it is essential to understand the parent material that the soil series has developed from because boron deficiency can destroy a crop (see Technical Note *TN671: Management of boron in soils for crops).* Boron can be added to a compound fertiliser for application to the seedbed, or a boron spray could be applied with herbicide when the cotyledons show in the crop. Where soil analysis indicates a deficiency, or for susceptible crops such as fodder beet, swedes, turnips and other brassicas, apply boron to the seedbed (2 kg/ha boron) or as a foliar spray according to manufacturer's recommendations as soon as leaf cover allows. It is usually sufficient to apply boron once during a rotation, but if root crops are being grown, it is advisable to apply boron prior to each of these crops, regardless of whether boron has already been applied in the rotation.

It is not advisable to over-apply boron, since toxicity can cause problems in some crops in the rotation (e.g. spring barley).

Key Environmental Tips

- **Apply fertiliser and lime according to soil test results**
- **Seek advice from a FACTS accredited advisor on nutrient application**
- **Ensure no fertiliser is applied within:**
  - **2m of any surface water or wetland**
  - **5m of a spring, well or borehole**
  - **2m of a hedgerow**

Manganese (Mn)
Manganese deficiency often occurs in high pH situations, dry sandy soils, and soft seedbeds and/or immediately after liming. A foliar manganese sulphate spray can deliver a sufficient supply to the crop.

Weed control

Forage crops can be quick growing (stubble swedes, forage rape and hybrid brassicas) making them competitive against growing weeds. The slower growing forage crops (swedes, kale and fodder beet) can be sensitive to weeds. Weeds should ideally be eliminated from the previous crop prior to establishment and in the case of fodder beet weed seedlings in the growing crop must be cleared. Various management options can prevent competition from weeds, including using a stale seed bed, ploughing to bury weeds, mechanical weeding and herbicides.

Always consult a BASIS accredited agronomist on herbicide use.

Pest Control

Pests that affect forage crops are similar to those that affect major crops such as oilseed rape and sugar beet. These pests include, flea beetles, cabbage root fly, butterflies and moths, aphids, slugs, rabbits and pigeons. For more information on the management and control of brassica pests see technical note 551.

The major crops have thresholds of when to treat for the smaller (insects) pests. Due to the difference in economics between the major crops and forage crops, the later tend to have higher tolerances. There are limited insecticide treatments available for brassica crops, consult a BASIS accredited agronomist for thresholds of the various pests and methods of control including treated seed.

A basic rule of thumb for flea beetles, is if 25% of cotyledons are damaged (holed) by flea beetles or 50% of the first leaves then the crop should be treated. This is especially the case in dry conditions which suit flea beetles.

Some crops are more affected by others, largely brassica crops have a thinner leaf than that of a waxy beet leaf, which can divert pests from attacking.

Disease Control

There is one main disease of brassica crops, clubroot. This only affects brassicas and not beet crops. This is a fungal disease that requires good integrated crop management to aid prevention. Preventative strategies include crop rotation, resistant varieties and liming soils.

Other diseases include alternia and mildew.

Key Environmental Tips

- **Consult a BASIS accredited agronomist for thresholds of the various pests and methods of control including treated seed.**
- **Consult a BASIS accredited agronomist for an integrated crop management plan to prevent disease**

Varieties

There are numerous different varieties of the different forages on the market. You must know how you plan to utilise the crop e.g. harvesting or feeding in situ when choosing the type and variety to sow. Other considerations are, yield, dry matter, winter hardiness and disease resistance.

The dry matter content of a crop gives a clear indication of when to utilise it. For example a high dry matter swede would be more winter hardy than a lower dry matter swede. A lower dry matter swede would be more suited to early grazing, while the high dry matter varieties would allow for utilisation in late winter/early spring and store well if lifted. Some growers choose to grow both high and low dry matter varieties, starting livestock grazing the low dry matter first and naturally reaching the higher dry matter variety as winter progresses.

For fodder beet there are white rooted and coloured varieties. The white rooted varieties often have a higher dry matter and have up to 80% of the root in the ground, often these are well suited for harvesting. The coloured varieties are lower in dry matter, meaning they are softer for livestock to eat. These coloured roots sit further out of the ground giving a good utilisation rate when fed in situ by livestock.

Utilising Forage Crops for Livestock

Forage crops offer a nutritious feed for livestock offering a nutrient balanced diet, with a high intake potential (see table 3 showing nutritional value).

The two main options for utilisation of forage crops, is grazing *in situ* (in the field) or harvesting the crop. The options are available for the following crops:

Kale – This is mainly utilised in situ, strip grazed behind an electric wire. This is often grazed by cattle, but is also relevant for sheep. It can grow quite tall and stocky which can reduce the level of utilisation by sheep. Kale can also be zero grazed or cut and baled (see below).

Forage rape and hybrids – these are generally better suited to sheep, such as finishing lambs and ewes. Grazing i*n situ* behind an electric fence or blocks is recommended.

Swedes - Suitable for cattle and sheep, can be grazed *in situ* or harvested and stored. When storing, roots must be clean and free from soil to prevent fungal diseases in the roots. When swedes are lifted the tops will either be taken off during harvest or will deteriorate in storage, these leaves are a high protein source which will be limited when harvested.

Stubble Turnips - Suitable for cattle and sheep. Grazing *in situ* behind an electric fence or blocks is recommended.

To maximise the utilisation of the forage in situ, the crop should be strip grazed using an electric fence. Ideally the strips should be long and shallow to prevent wastage and trampling of the crop and benefit the shy feeding animals. Daily or twice moves of the electric fence are recommended to ensure the crop being offered is fresh and palatable.

Livestock must be gradually introduced to the crop, to minimise digestive upsets. The transition time should initially allow for animals with a full stomach, only 1-2 hours on the crop per day. The time on the crop should steadily be increased until the animals have constant access to prevent digestive upset.

Animals should have an *ad lib* supply of fibrous forage such as hay, silage or straw as well as having a clean run-back area. The run-back area is essential to enhance animal welfare while offering the animals an area to forage on grass as well as a clean, dry surface for loafing, ideally this would be a grassy headland in the field. Forage such as hay, silage or straw should ideally be placed in the field while ground conditions are favourable to prevent soil damage from machinery such as tractor wheels. In addition to fibrous forage *ad lib* minerals and trace elements should be offered to the sheep grazing the fodder beet.

When ground conditions are unfavourable, then grazing the forage crops with light livestock would be preferable e.g. light store cattle, weaned calves or sheep.

An alternative to grazing animals in situ on the leafy forage crops e.g. kale, is to zero graze them, as long as conditions allow machinery to be carried on the field. Zero grazing means to lift the crop and feed it immediately to animals. Benefits of this system are feeding the crop to heavy animals that may cause ground damage, or to high performing animals that are housed e.g. dairy cows.

Some choose to harvest the crop and make "brassica silage" for use throughout the winter to feed to livestock. This would be applicable for leafy brassicas such as kale and not bulb crops. After cutting it is important to ensure this crop has been allowed to wilt in the field, to reduce the water content of the silage. This will reduce spoilage of the stored crop and reduce the volume of effluent it produces. The crop can be wrapped and stored in big bales. An option to reduce the amount of effluent and reduce the weight of the bales would be to blow chopped straw along the bout on top of the wilting forage crop, the bale would then be a mix of forage crop and straw.

The table below should be used as a decision tool to understand how much fodder crop to grow for each stock class.

Table 14: Decision tool on utilisation

Crop	DM yield (t/ha)	Number of animals/ha over 90 days				Days until Utilisation
		Sheep		Cattle		
		Ewes	Lambs	Cows	Stores	
Kale	9	96	119	6	14	154 – 210 days
Rape & Hybrids	3.5	37	46	3	5	70 – 110 days
Stubble Turnips	4	43	53	3	6	56 - 100 days
Swedes	9	96	119	4	14	170 – 220 days
Fodder Beet	17	181	225	12	26	175 – 210 days

The above table has been based on, utilisation at 70% of the diet, and allowing for 25% wastage. Pregnant ewes (70kg) intake 1.6% of LW, lambs (30kg) 3% of LW, cows (750kg) and stores (350kg) 2.2% LW.

Feed Allocation

The dry matter yield shown above in table 14, are taken from book values. This will vary depending on the yield, variety 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.
To calculate the dry matter yield all that is required is

- 1m square quadrat or 2.66m of alkathene pipe in a loop
- a bag
- a pair of shears or knife
- a set of hand held scales
- note pad and pen

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.

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 gives the fresh weight per hectare.

Step 5: Multiply the result by the estimated dry matter of the crop (e.g. kale 15%) and divide by 100 to calculate the dry matter per hectare.

E.g. Total bag weight of 7kg x 10,000 = 70,000kg fresh weight per hectare x 15% (estimated dry matter) = 10,500kg / 1,000 = 10.5 tonnes dry matter per hectare.

Using the dry matter (DM) yield a daily allocation can be calculated depending on the stock class grazing the crop. An example is shown over for a 70kg ewe.




Table 15 – Calculating Daily Allocation (adapted from AHDB)

		Example: 70kg ewe
A	Total Estimated Intake (using 1.6% of liveweight)	1.20kg DM/day
B	Crop Inclusion of The Diet (allowing 30% fibrous forage)	70%
C	Daily Requirement of Forage (AxB)	0.84kg DM
D	Number of Animals Grazed	300
E	Daily Requirement of Fodder Beet (CxD)	252kg DM
F	Estimated Crop Yield (DM/m2) (crop yield as above – 10.5 tonnes @ 80% utilisation – (1.05kg/m2 x 0.8)	0.84 kg/DM/m2
G	Total Grazing Area Required/Day (E/F)	300 m2
H	Length of Electric Fence (Feed Face)	150m
I	Width of Fence Moved Per Day (G/H)	2.00m/day

Using the simple dry matter and daily allocation calculations, instructs how far to move the electric fence on an daily basis to ensure high utilisation.

Calculate the area required for the winter with a feed budget, as shown below for 70kg ewes.

Table 16 – Calculating Feed Budget (adapted from AHDB)

	Follow steps A-C as above	Example: 70kg ewe
C	Daily Requirement of Forage (AxB)	0.84kg DM
D	Feeding Period	120 days
E	Total DM Requirement per Animal (CxD)	101kg DM
F	Total Required for flock (e.g.300 ewes x E/1000)	30.30 tonnes DM
G	Forage Utilised Yield (t DM/ha) 10.5 tonnes @ 80% utilised	8.40 tonnes DM
H	Forage Area Required for Winter (F/G)	3.60 hectares

- Ensure an area of run-back is also budgetted for.

Livestock Management While Grazing Forage Crops

Forage crops can be grazed by all stock classes. All animals should be condition scored, prior to going on to forage and condition must be monitored throughout the grazing period. Any animals which are above or below the desired condition score should not be grazed with the main mob, and instead be managed separately and brought to the appropriate condition score for the time in their breeding cycle.

The different types of forage crop, have a range in dry matter e.g. high (fodder beet) and low (stubble turnip). The higher the dry matter, the less water is in the crop, the lower the dry matter the more water, and the crop would be softer to eat. Some high dry matter crops may prove difficult for some classes of stock to graze e.g. older ewes/tups who may have lost/worn teeth. The condition of the animals should be monitored throughout the time grazing on the crop, if it seems that animals are losing condition, then remove the animal(s) and identify the reason e.g. lameness, lack of teeth etc.

Ensure animals feet are sound before grazing forage crops. When grazing a long narrow strip, ground can be contaminated quickly. Remove and isolate lame animals and treat accordingly. Minimise continuous travelling on ground e.g. through a gate way to adjoining run-back to reduce associated feet problems and poaching of the ground.

Belly clip young stock such as feeding lambs, prior to grazing on forage crops to prevent contamination. This will ensure lambs are clean for slaughter or for breeding ewes, to ensure the ewes belly and udder is clean when lambs are searching for the teat at lambing time.

As with transitioning livestock "on" to forage crop gradually, it is equally important to transition livestock "off" forage crops gradually to prevent digestive upsets. This may be achieved by reducing the daily allocation gradually, shutting animals off the crop for a longer period of time gradually or giving access to more forage.
Utilising the crop with livestock allows for a quality feed when grass growth is limited. Forage crops offer a relatively cheap complete ration for livestock, but these must be managed appropriately to prevent conditions such as

- Photo-sensitisation
- Nitrate poisoning
- Goitre
- Redwater
- Bloat
- Toxic flowering brassicas

Cost to Grow Forage Crops

Forage crops vary in price to establish and grow, depending on the inputs required from inorganic fertiliser, seed rates and other costs such as herbicides and fungicides. The cost of production is usually related to the yield of dry matter that is achieved from the crop. Average growing costs for the 2019 year are shown below.

£/ha	Kale	Forage Rape & Hybrids	Stubble Swedes	Swedes	Fodder Beet
Ground Work					
Ploughing	£64	£64	£64	£64	£64
Levelling	£31	£31	£31	£31	£31
Sowing	£24	£24	£24	£54	£64
Rolling	£13	£13	£13	£13	£13
Spraying	£12	£-	£-	£12	£24
Fertiliser Spreading	£17	£17	£17	£17	£34
TOTAL	**£161**	**£149**	**£149**	**£191**	**£230**
Inputs					
Seed	£52	£21	£21	£39	£200
Fertiliser	£218	£100	£151	£265	£176
Salt	-	-	-	-	£25
Spray	£20	-	-	£41	£141
TOTAL	**£290**	**£121**	**£172**	**£345**	**£542**
TOTAL COST	**£451**	**£270**	**£321**	**£536**	**£772**
DM of crop (t/ha)	8-10	3.5	4-5	7-10	15-18
Cost / t DM	**£50**	**£77**	**£71**	**£63**	**£46**

Assumptions

- Ground work rates taken from machinery ring February 2020. Allowing for two passes of fertiliser and spraying for fodder beet and one for other crops.
- Input costs from SAC farm management handbook 2018/19
- Fertiliser application should be tailored to previous crop and soil analysis, this is an example only
- Costs can be reduced by direct drilling or broadcasting and not ploughing if following an arable crop.

As an example if we use kale yielding 9 tonnes of dry matter (DM) per hectare, fed to 70kg ewes for a 100 day period the cost per day would be £0.04 and over a 100 day feeding period £4.00 (calculation shown below).

Table 10 – Calculating Wintering Costs of Feeding Forage Crop

A	Cost of Production	£451/ha
B	Estimated DM Yield	9 tonnes/ha
C	Cost per Tonne of DM (A/B)	£50/tonne DM/ha
D	Cost per kg of DM (C/1,000)	£0.05/kg DM/ha
E	Daily DM Requirement of Forage Crop (see table 14/15)	0.84 kg DM
F	Cost per day per head (DxE)	£0.04
G	Feeding Period	100 days
H	Total Cost per Feeding Period per head (FxG)	£4

Top tips for growing success

1. Soil test and correct pH, phosphate, potassium and magnesium levels
2. Select sheltered, relatively flat field with light to medium, free draining soil
3. Remedy compaction issues and establish fine firm seed bed
4. Remove all weeds
5. Choose type and variety according to when utilisation is planned and the stock class chosen
6. Sow when soil temperature exceed 5˚C
7. Monitor for pests such as slugs, flea beetle and cabbage root fly and treat on advice from a BASIS accredited agronomist

Feeding in the field effectively

1. Measure the dry matter available per hectare
2. Estimate the flock/herd requirement
3. Use this to determine electric fence shifts and calculate area required for the winter

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