Livestock and the arable rotation

Contents

AHDB is grateful to all those who have commented on and contributed to this publication.

Photography: AHDB, Germinal and Oliver Seeds

Introduction

Why incorporate livestock in the arable rotation?

Farming in the UK has become increasingly specialised in recent times, with arable enterprises dominating the East and livestock farming dominating the West (see Figure 1). Questions about the economic and environmental sustainability of such systems, however, means farmers and agronomists are increasingly looking at the potential to incorporate livestock within arable rotations.

Including livestock in the rotation can bring multiple advantages, including improving soil health and weed management. The aim is to increase the productivity of arable fields, particularly those identified as underperforming. By working with other farming enterprises, income streams can be diversified and the risks of production spread, leading to mutual benefits for both parties.

This publication is designed for managers of arable-based systems who take a long-term view on production, which is necessary to account for the possible benefits of including livestock in the rotation. It presents some of the opportunities available, as well as the key things to be considered.

It includes, or signposts to, information on markets, contracts, infrastructure, logistics and some of the many advantages and disadvantages. It also includes several case studies to illustrate the potential of working in partnership with livestock enterprises.

This publication should be used in conjunction with the wide range of literature published on cereals.ahdb.org.uk/livestock

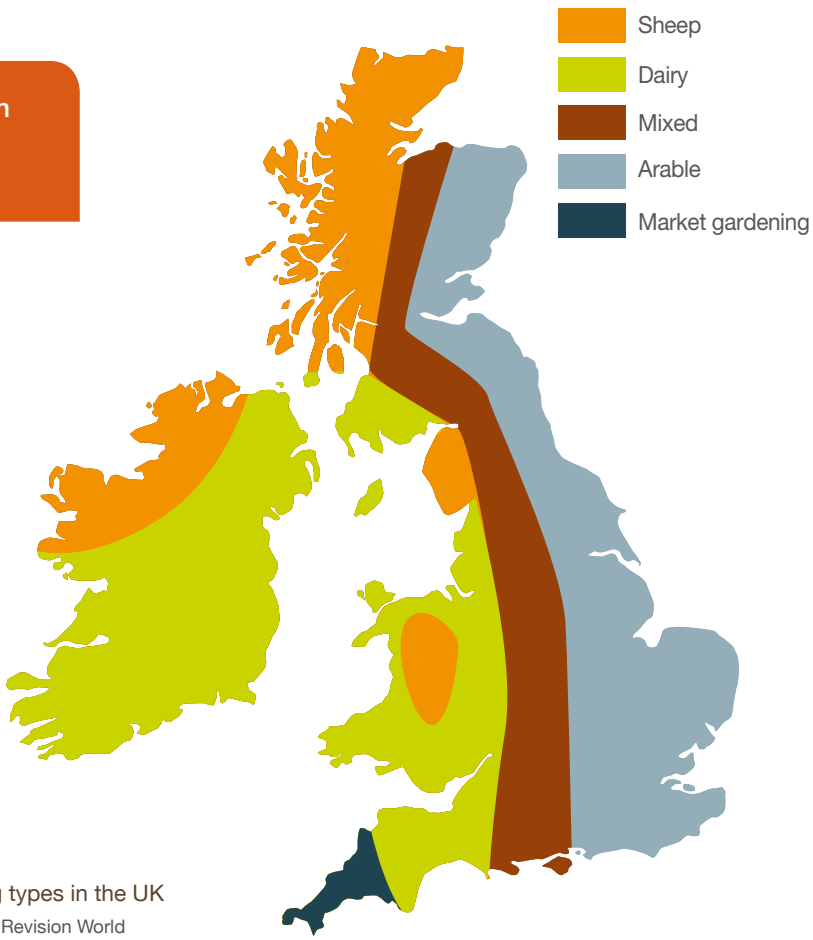

Figure 1. The main farming types in the UK

Source: European Commission, Revision World

Options for working with others

This publication looks at how an arable business can work with livestock businesses to optimise both enterprises. Some of the main options to work with others are presented in Table 1.

Table 1. Options for working with livestock farmers

	Beef and lamb	Dairy	Pigs
Muck-for-straw deals	✓	✓	✓
Host out-wintering livestock (eg dry cows, rearing heifers or beef cattle)	✓	✓	
Contract growth of forage crops (eg silage, maize or cover crops)	✓	✓	
Grazing or cutting agreement (up to one year)	✓	✓	
Grazing licence for a grass ley or grazing (up to two years)	✓	✓	✓
Farm business tenancy agreement (eg for outdoor pig production)	✓	✓	✓
Joint ventures (eg share milking agreement)	✓	✓	✓

There are numerous business models that can be used to set up agreements before incorporating livestock within an arable rotation. Legal advice should always be sought before setting up a working relationship.

It is essential that agreements are reached before livestock arrive on the farm.

Agreements should be made in writing, fully stating each party's intentions and expectations of the relationship. It should include, for example, which party is responsible for all aspects of husbandry and care and which party is claiming subsidy or agri-environment payments. The parties should also ensure adequate markets are available for the products generated by any agreement.

Some examples of the agreement types that can be used between farms for the opportunities described in this publication are outlined below.

Muck-for-straw deals

Exchanging muck for straw is a relatively simple and convenient arrangement. The arable business provides straw for bedding. In return, the stockperson provides an enhanced product that is rich in nutrients and organic matter. Agreements can vary significantly. The key things to agree on are how much muck and straw will change hands and who will pay for and carry out baling, transportation and spreading. For further information, see the 'Opportunity: manures' section (page 22).

Grazing or cutting agreement

This is appropriate when the landowner is looking to rent out grass for grazing or to 'take a crop of grass' for less than a year (short-term agreement). Breeding enterprises cannot be grazed using a grazing agreement. It is neither a lease nor a license to occupy, but a right to buy and take a crop. The landowner continues to claim subsidy on the land. The grazier has no rights of occupation and can be asked to leave quickly.

Figure 2. Sheep grazing

Grazing licence

This is more formal than a grazing agreement. The grazier still has no right to occupy the land and can be asked to leave quickly. Often, the landowner also continues to claim subsidy on the land. The licence, however, can last up to two years and a fee is paid (generally as a lump sum), rather than rent.

Farm business tenancy agreements

This agreement is used when someone grazes animals on crops that are being taken over a period longer than one year, with rent being paid. Such agreements can be used in England and Wales (for Scotland, consult the Scottish Government or an adviser) and require a minimum notice period of 12 months to terminate. This type of agreement is best used in an existing, successful relationship; for example, after a two-year grazing licence.

Figure 3. Working in partnership can bring returns to all enterprises involved

Joint ventures

Joint ventures allow two or more separate businesses to work together and can range from being quite simple to more complex, but all arrangements are based on a willingness to collaborate. Contract farming agreements are probably the most common - the farmer typically provides the land and buildings and the contractor usually supplies the labour and machinery. Both parties receive a first charge which should cover their costs, plus a split of the divisible surplus based on a pre-agreed ratio. Agreement lengths are normally determined by the level of investment needed and may be fixed and reviewed prior to an optional renewal. Other joint ventures offer parties the chance to further combine their skills and resources to grow a separate business. Profit has to be the driving force behind such a venture with the focus on income, opportunity and growth.

Figure 4. Shelter for livestock in the field

Things to consider

- If moving livestock between farms and areas, health and disease risks must be considered (eg bovine tuberculosis, 'TB'). For further information, visit **tbhub.co.uk**
- Livestock should be managed by trained and experienced stockpeople with good powers of observation and the ability to care for stock so as to cause them minimal stress through suitable grouping, feeding and handling. A grazing agreement can make reference to the five welfare needs described in the Animal Welfare Act. For further information, visit **gov.uk/animal-welfare**
- Cross-compliance: to reduce the risk of soil erosion, compaction and diffuse pollution, location and soil type should be considered when looking at options
- To minimise the risk of soil poaching and run-off, fields with sandy soils, good soil drainage and gentle slopes are preferable to poorly drained, heavy clay soils or steep slopes
- Buffer strips (such as uncultivated or undrilled land) should be incorporated at the bottom of slopes or near areas where run-off is a risk
- Ideal sites offer shelter for livestock but have sufficient air flow to allow fields to dry out
- Consider fencing, watering and feeding facilities, along with good handling facilities to minimise stress. If indoor housing is required, accommodation should be well ventilated, have sufficient space, feeding facilities and be designed for ease of cleaning
- Consider including a run-back (a loafing or grazing area at one end of a field where stock may find shelter)
- Organise feed fences to provide maximum frontage and a narrow strip of accessible forage, but avoid overstocking
- Avoid vehicles travelling in the field during winter by putting bales out in the late summer or autumn

Opportunity: leys

Grass and clover leys can be a useful addition to an arable rotation, particularly to manage weed problems, such as black-grass, or to build soil fertility. Timing of grass establishment is flexible. Typically, grass can be established anytime between April and September, as long as soil moisture is not limiting.

Grass leys are most likely to be established in arable rotations in the autumn, after harvest. This allows the seedbed to settle over winter and a good structure to form. However, if grass is established this late in the season, weed competition can be significant and there can be a narrow window for good establishment. Grass leys can also be established in the spring after over-wintered stubbles or a cover crop.

Six months before establishing grass, it is important to check that the field drainage system is working and fit for purpose (see the **AHDB Field drainage guide**) and to test the field's soil (at least two months after the last application of manure, fertiliser or lime).

Figure 5. Always check the land's suitability for livestock

Options for leys

Leys can be utilised in various ways (listed here in order of increasing risk to the landowner):

- Grazing rented out for a season or for the life of the ley
- Standing crops sold to others to make silage or hay (this can be done for the whole season or for particular cuts and tend to be sold on a per hectare basis)
- Contract-grown crops (eg lucerne for horse feed) for other companies that may look after the agronomy and harvest
- Livestock owned by others graze the land but the landowner has responsibility for looking after the stock (this can be done on a liveweight gain or pence per day contract)
- Silage made by the landowner and sold to local farmers or to anaerobic digestion plants (can be sold on a fresh weight/dry matter basis or on quality)
- Livestock bought by the landowner to graze the crops or eat the conserved silages or hay

Case study: using leys for grazing and forage

Farmer: Matt House
Farm: Bowden Farms, Somerset

Matt has been involved with AHDB's Beef from Grass project for the last two grazing seasons. He has made significant improvements to his grazing management, including a 40 per cent increase in output per hectare.

Currently, he grazes around 120 Aberdeen Angus cross suckler cows plus calves, 90 bulling heifers and 75 replacement heifers on a rotational grazing system on two day shifts. His target is to increase the herd to 300 suckler cows with no housing.

His stocking rate has increased from 1.62 livestock units per hectare (LSU/ha) to 2.33. He no longer grows cereals and sells forage off his farm, although this practice will reduce as the size of the herd increases.

Matt has worked with a dairy farmer for the last two years and negotiates a payment per hectare. Matt drills long-term cutting leys on around 40ha, because it provides flexibility (eg if the land is needed for cattle grazing). The dairy farmer develops the nutrient management plan for the required yield, buys and applies the fertiliser and manages the silage operations. As part of the agreement, the dairy farmer has access to the grass for fewer than six months, allowing Matt to use the land for grazing early and late in the season.

Matt is actively looking for opportunities with local arable farms to away winter his cows on a brassica crop.

Ley types

Leys tend to be made up of mixtures (including grass, clovers or herbs) and are often in the ground for at least one season. Common options include:

- Long-term leys (up to five years), which are often made up of grasses and clovers, with the option of adding additional herbs, such as chicory and plantain. Although these can be cut, they are more often grazed for most of the year
- Cutting grasses, such as Italian or hybrid ryegrasses, which produce a significant yield in the first two years but should then be replaced
- Fields of lucerne or red clover (becoming more common)

More information on chicory, plantain and lucerne can be found in the AHDB **Growing and feeding lucerne** and **Using chicory and plantain in beef and sheep systems** publications.

Figure 6. Chicory at various stages of growth

It is important to select the right type of grass and clover for the purpose of the ley, because this will affect seed costs and how long the mixture will last. Specialist silage leys require the least amount of time in a rotation (see Table 2).

Options for clover

Typically, for white and red clover, it takes around one year for the quoted levels of nitrogen to be fixed – up to 150kg N/ha for white clover and up to 250kg N/ha for red clover. They can, therefore, be difficult to justify in a short-term ley. However, clover improves feed quality for livestock, with high growth rates and high protein content in silage.

Annual clovers, such as berseem and crimson, fix nitrogen in the first year but tend to die away during the winter. Most of the nitrogen is within the growth, which will be returned to the soil as the plant decays or through the dung and urine of grazing animals.

Figure 7. White clover

Table 2. Guidance on when to use types of grasses and clovers

	Specialist silage leys (1–3 years)	Medium-term cutting and grazing leys (2–4 years)	Long-term cutting and grazing leys (5+ years)
Perennial ryegrass (diploid)	✗	✓	✓
Perennial ryegrass (tetraploid)	✓	✓	✗
Italian ryegrass	✓	✗	✗
Hybrid ryegrass	✓	✓	✗
Timothy	✗	✓	✓
Cocksfoot	✗	✓	✗
White clover (small leaf)	✗	✓	✓
White clover (medium leaf)	✓	✓	✓
White clover (large leaf)	✓	✓	✗
Red clover	✓	✓	✗

Opportunity: leys

Ley varieties

Variety selection is key when establishing grass. Some varieties perform better under silage than under grazing and vice versa. Consequently, it is important to consider whether the grass ley will be mostly cut or mostly grazed because selecting the correct variety can have a significant impact on financial returns.

The **AHDB Recommended Grass and Clover Lists** are equivalent to the **AHDB Recommended List for Cereals & Oilseeds.** It provides an independent testing system to ensure the best grass and clover varieties are available for selection.

Most grass leys are sown as a mixture of diploid and tetraploid ryegrasses, sometimes with a small amount of other species (eg clover or timothy).

Mixtures are commonly sown to minimise the risk of a crop of seed failing, to ensure sward quality (throughout the grazing season) and to achieve a balance of desirable traits.

Some key tips for selecting mixtures:

- For grazing mixtures, choose varieties with a heading date range of less than 15 days
- For cutting mixtures, choose varieties with a heading date range of less than seven days
- Be aware that open-growing diploids tend to be more aggressive than dense-growing diploids, when sown with tetraploids in a mixture
- Have a minimum of 3kg/ha of any variety in a mixture

Ley cultivation and establishment

The primary aim of any cultivation for grass ley establishment, as with all crops, is to provide a good environment for a seed to germinate. Provide:

- Good seed-to-soil contact
- A fine well-structured seedbed, to ensure a good supply of oxygen and to support root development
- Sufficient moisture retention for seed germination
- A weed-free seedbed
- A consistent sowing depth (dependent on the seed size) and consolidated, where applicable

Various cultivation approaches can be used in grass ley establishment. Some example costs associated with reseeding techniques are given in Table 3.

Seed rates for grassland establishment vary from 18–35kg/ha. Traditionally, high seed rates have been used as an insurance policy to reduce the risk of weed infestation or to compensate for poor emergence rates. Uneven sowing depths, variation in seedbed quality or low soil moisture levels can hinder germination.

Typically, broadcasting seed can result in better ground cover. In dry areas or on light soil, however, drilling into a prepared seedbed (eg with an air seeder in spring) can ensure the seed is placed in contact with soil moisture. In these conditions, seed rates can be reduced by one third.

Table 3. Example costs associated with reseeding techniques (£/ha)

	Full cultivation	Minimum-till cultivation	Overseeding
Soil analysis	3	3	3
Spray	30	30	
Spraying	27	27	
Plough	61		
Power harrow	50	50	
Power harrow	50		
Land leveller	17	17	
Seed	161	161	79
Sow	22	79	79
Roll	17	17	17
Fertiliser - 100kg 18:14:14 + spreading	94	94	94
Lime - 2t + application	126	126	126
Leatherjacket control	12	12	12
Slug pellets	20	20	20
Total cost (£/ha)	**689**	**636**	**430**

Figure 8. Broadcasting seed can result in better ground cover

For best results, aim to sow seeds within 1–2cm of the soil surface. However, for very small seeds, such as clover, a sowing depth of less than 1cm is usually necessary to ensure emergence.

It is extremely important to consolidate the seedbed after drilling to ensure good seed-to-soil contact and reduce water loss. It may also help control pest issues.

Grass establishment also provides a good opportunity to incorporate organic manures into soil. This adds organic matter, provides a food source for soil organisms and assists with the development of good soil structure.

Recommendations for nutrient management for grass establishment can be found in Section 3 of the **AHDB Nutrient Management Guide (RB209)**.

The new ley should be grazed as soon as it becomes difficult to pull it out of the ground by hand. This is usually at the two-leaf stage or when the grass is 8–12cm high. Autumn reseeds should be grazed before the first winter to encourage tillering. Work conducted in Ireland (by Teagasc) suggests grazing at around 6–8cm in the autumn, but making sure it is grazed tight (4cm) before the winter.

To minimise any potential soil compaction, overgrazing or poaching – particularly in wet conditions – the lightest class of stock available (eg sheep or youngstock) should be used for the first grazing. Do not apply excessive slurry in wet conditions.

Seeding rates for clover swards need careful management to ensure that white or red clover do not become dominant. Careful grazing or strategic applications of nitrogen can be used to adjust clover levels.

Further information, including on pest and weed management, can be found in the **AHDB Grassland reseeding guide**.

Opportunity: leys

Leys and black-grass control

Turning over arable fields to grass can be a highly effective way of reducing the black-grass burden on a field.

Black-grass seed decline

Black-grass seed is relatively short lived in the soil, with seed number declining at around 70 per cent each year. There is no evidence that this rate varies with soil type or soil moisture. Therefore, if black-grass seed return is prevented by cutting or grazing a grass ley, the seed bank declines rapidly. Where the seed bank contains substantial numbers of black-grass seeds, even after several years under grass, there will still be a substantial number of viable black-grass seeds in the soil.

Black-grass palatability

Black-grass has low palatability for livestock and the amount of black-grass in the sward should be minimised. If the preceding arable crop had a high black-grass burden, then ploughing is recommended to bury the seed below the germination depth. Delayed drilling of the ley in the autumn, until after the peak black-grass germination period, or drilling in the spring, will further reduce the number of black-grass seeds germinating in the grass sward. In either case, cultivations should be used to prepare a sterile seedbed, which can be managed with further cultivation and glyphosate. Minimising soil disturbance when drilling the ley will minimise any black-grass germination. There are no herbicide options for controlling black-grass in the ley if it is to be used for grazing or conserved herbage.

Returning to arable production

When returning the grass ley to arable production, some viable black-grass seed will still be in the soil. Soil disturbance will stimulate this seed to germinate. Consequently, spraying off the grass sward with glyphosate and direct drilling is likely to result in the lowest black-grass population in the first crop following the grass. Winter wheat may be the preferred first cropping option to exploit the soil fertility built up during the ley. However, longer leys will have a higher burden of pests that will attack wheat (eg frit fly and leatherjackets). Increased seed rates can reduce the impact of these pests but oilseed rape (OSR) or beans may be a better option for the first crop after a longer ley, although soil moisture can be an issue for autumn-sown OSR after a vigorous grass ley. Maize is also an option after grass, with the potential to sell this following crop.

An initial spring crop will minimise black-grass in the first crop after the ley and, if the ley is destroyed in the preceding autumn, this can reduce the soil pest burden. Whichever crop is used immediately after the ley, a robust pre-emergence herbicide programme should be used to tackle any surviving black-grass. Going forwards, an integrated weed management approach to black-grass, incorporating cultural control options, such as delayed drilling, spring cropping and appropriate cultivations, will be required to prevent the black-grass populations increasing rapidly again, particularly where herbicide resistance is present.

Figure 9. Drilling grass

Figure 10. Black-grass

Ley yields

Leys should be treated like an arable crop, with good soil structure and nutrient supply to ensure yields are maximised. The world record for dry matter yield of grass is around 25 tonnes of dry matter (t DM) per hectare. Yields in the Recommended Grass and Clover Lists trials tend to be around 16–18t DM per hectare under cutting regimes, with newly sown plots and with high levels of nitrogen being applied. The target for commercial grazing systems in the UK and Ireland is to utilise 10t DM per hectare. Guidance on yields for a range of ley crops is presented in Table 4.

Dry matter (DM) is the most common way of expressing grass growth, as it takes into account differences in the water content at different times of year.

The need for multiple harvests, through cuts or grazing, means it is crucial to focus on utilisation, because this has an important impact on cost of production. Utilisation can vary from less than 50 per cent to more than 80 per cent in well-managed systems.

Improved utilisation is linked to investment in infrastructure (eg fencing systems for grazed swards or machinery for cutting systems) and allocation of labour.

More information on grazing techniques, including measuring grass and infrastructure, such as electric fencing, can be found in the **AHDB Better Returns Programme (BRP) manuals.**

Opportunity: leys

Case study: flexible options for grazing

Farmer: James Evans
Farm: Partridge Farm, Shropshire

James farms around 950ha in partnership with his family. Of this area, 575ha is contract-farmed (some under conversion to organic production) and the rest is owned. He has 300 high-health Stabiliser cows, used mainly for breeding bull and heifer sales, and in April he also lambs 500 Lleyn ewes outdoors.

James also has 60ha of arable land that is drilled with herbal leys (a mix of grass, clovers and herbs) for grazing. Half of the area is for permanent grazing and the other half is moved around the arable rotation to build fertility.

During autumn 2017, James worked with James Daniel from Precision Grazing to develop a TechnoGrazing system for his beef cattle. TechnoGrazing systems use bespoke electric fencing and water equipment to divide an area of land into precisely defined lanes. These are sub-divided into cells to create a grazing rotation, the length of which can be quickly adjusted to suit requirements while maintaining access to water. The ambition is to graze two mobs of 45 cows and calves over the grazing season, with a focus on liveweight gain for spring-born calves.

See the **AHDB Electric Fencing for Livestock publication** for further information.

Table 4. Guidance on yields of a range of ley crops

	Average fresh weight yield (t/ha)	Dry matter (%)	Average dry matter yield (t/ha)	Average metabolisable energy (MJ per kg dry matter)	Average crude protein (% in dry matter)
Grazed grass (whole year)	65	17	11.1	11.5	17
Poor-quality sward (whole year)	40	18	7.2	10.5	15
First-cut grass silage (clamp)	23	25	5.7	11.2	15
Second-cut grass silage (clamp)	13	30	3.8	11.0	14
Hay (one cut)	6	85	5.0	9.0	9
Italian ryegrass (whole year)	52	27	14.0	11.0	13
Conserved lucerne (whole year)	40	30	12.0	10.0	17–22
Herbal ley (whole year)	67	15	10.0	11.0	18

Cost considerations: leys

As with all crops, understanding production costs is crucial to ensuring the enterprise is profitable. This example calculates the cost of silage.

Step 1: Work out costs on an area basis

Rental value – Everything grown on a farm carries a rental value. Land could be let for a standard figure of £250/ha/year, if it not used to grow a silage crop. First-cut grass normally produces 40 per cent of the total annual yield.

Establishment and grassland management – On average, reseeding costs are £250/ha* (£50 a year for a five-year ley). Allocate 40 per cent to first-cut silage. Include weed control expenses on the same basis.

Inputs – Limited on grassland, but with key crops, like maize, include appropriate costs (eg sprays and plastic).

Machinery – Most contractor operations are easy to allocate on an area basis. The calculations can get more complicated when the farm makes its own silage. Use contractor prices as a guide.

Other costs – These include additives, sheeting and analysis and are usually recorded on a per-clamp basis. Simply divide the total by the area going into the clamp.

* Full reseed, including ploughing = £375/ha. Overseeding = £175/ha.

Step 1: example
(40ha, first cut, 68 D-value)

Costs/ha
£250 × 40% = £100

Reseeding costs = £20

Fertiliser (400kg of 20:10:10)
£270 × 40% = £108

Slurry application = £49.50

Rolling = £26

Fertiliser spreading = £5

Mowing = £12

Tedding/rowing = £19.50

Carting/clamping = £128

Additive = £800/40ha = £20

Sheet and analysis cost
£120/40ha = £3

Total/ha = £491

Step 2: Estimate the yield

Step 3: Work out costs – pence per kilogram of DM (p/kg DM)

- Divide the total area costs by the estimated yield (eg 20t FW/ha)
  £491/20t fresh weight (FW) = £24.55/t FW = 2.5p/kg FW
- Convert costs of FW into DM variable costs = cost/kg FW x (100/DM%)
  So @ 25% DM = 2.5 x (100/25) = 10p/kg DM
- Compare the cost of silage to other feeds available to buy or sell, convert the costs of a kg DM into pence of mega joules of metabolisable energy (MJ ME)
  So grass silage at 11MJ of ME/kg DM = 10/11 = 0.91p/MJ of ME

More information on making silage can be found in the AHDB **Making Grass Silage for Better Returns, The Home-grown Forages Directory** and **Managing your Silage Making** resources.

Opportunity: cover crops

In arable rotations, cover crops are grown primarily for the purpose of 'protecting or improving' between periods of regular crop production. Their main uses include to improve soil fertility or soil structure, manage weeds and pests, and for environmental management. They may also be grown for short-term animal grazing.

What are cover crops?

The terms 'cover crop', 'catch crop' and 'green manure' are sometimes used interchangeably but they can also be used more specifically to distinguish between different functions.

Cover crops are grown in the period between harvest and the establishment of main (cash) crops

Catch crops are grown to 'catch' the available nitrogen in the soil and prevent nutrient losses via run-off and leaching

Green manures are grown to improve nutrition for the following crop, through addition of fresh biomass (organic matter) and nutrients to the soil

Cover crop types

Cover crops can be grouped as cereals and non-cereals, with the latter group including brassicas and legumes. For crops in the same family (eg brassicas and oilseed rape), consideration must be given to potential rotational conflicts in terms of pest and disease carry-over. For grazing, consideration must be given to suitability to grazing.

Grasses and cereals (eg oat, rye and rye-grass) can be grazed and deliver good early ground cover (which is important where erosion is a concern), as well as other benefits, including vigorous rooting.

Figure 11. Vetch can be used for animal grazing

Autumn-sown brassicas (eg mustards, radishes and turnips) can be grazed, with care, and often provide good ground cover and deep rooting. This can mitigate leaching risks and improve soil structure.

Legumes (eg sainfoin, vetch and clovers), which fix nitrogen, can be grazed with care and can benefit following crops and raise fertility. The amount of nitrogen fixed depends on the species, growth and temperature but is likely to be small with an overwintered cover crop.

Other cover crop species include buckwheat, chicory and phacelia. Chicory is a deep rooted cover crop (delivering soil structure benefits) and is better suited to longer-term use, especially where grazing is of interest. It can also be used in mixtures. Some cover crops claim to have an allelopathic effect.

Figure 12. Sheep grazing a cover crop

Cover crop destruction

Cover crops can be destroyed mechanically or by livestock grazing. Grazing can release nitrogen, phosphate, potash and other nutrients, making them more available to the following crop, compared with mechanical incorporation.

Cost/benefit

The cost of growing cover crops is between £15 and 55/ha, depending on whether the species mix is bought in or made on-farm. It is possible to keep costs down by growing some of the species mix on farm and home saving.

For the latest information on cover crops, visit **cereals.ahdb.org.uk/covered**

Figure 13. Fodder radish can be used for animal grazing

Case study: grazing cover crops with sheep

Farmer: Russell McKenzie
Farm: John Sheard Farms, Cambridgeshire

Russell farms 750ha of land on predominantly heavy clay on the border between Cambridgeshire, Bedfordshire and Northamptonshire. With a move towards no-till, Russell grows cover crops to enhance soil health and organic matter. He uses a mixture of key species, including phacelia, oats, linseed and, in some instances, a wider mix with sunflowers, vetch, radish and peas.

The cover crops are grazed by sheep, which act as natural recycling units. The sheep are provided by a neighbouring farmer, who also supplies the fencing and livestock husbandry.

"The key is not to overgraze and damage the soil surface. Grazing allows the natural elements to dry the surface ahead of spring arable drilling" said Russell.

Integrating livestock and cover crops into his rotation has allowed Russell to improve the soil infiltration on his fields. It also provides more consistent conditions to drill into in the spring. As the soil organic matter increases, the soil's ability to withstand traffic and reduce the potential impact of compaction goes hand in hand.

Russell's top three tips for anyone considering growing and grazing cover crops:

1. Start with small areas to gain confidence and build from there.
2. Try different things and experiment; you learn more by making mistakes than by getting it right first time.
3. Long-term gains outweigh expectations of instant returns.

Opportunity: forage crops

Forage crops, such as forage rape or stubble turnips, can provide nutritious, cost-effective feeds for cattle and sheep. These crops do not fit into every system and site selection is crucial – especially when used for outwintering.

Attention to crop nutrition and agronomy is important for a successful yield. Soil tests should be conducted eight weeks before sowing and the pH should be at least 5.6 (optimum 5.8–6.2). Manures, fertiliser and lime should be applied according to soil test results. Weeds should be controlled before sowing.

Growing forage brassicas will affect the clubroot break for oilseed rape.

Forage crop types

To determine the most appropriate crop, it is important to understand how the crop is going to be used (ie fed to own stock, rented out, lifted or sold) before it is sown, as well as when the field is available for sowing and when it needs to come back into the arable rotation. The range of sowing and feeding dates is summarised in Table 5.

The most suitable brassicas for grazing during the late winter months are kale, swedes and certain multigraze rape/kale hybrids. Stubble turnips, grazing turnips and forage rape are less winter-hardy but are ideal for extending the grazing season to the end of the year.

Brassica crops for grazing

Early sowing leads to higher yields in both root and leafy brassicas. However, crops can become less digestible as they mature, so utilisation will fall if they are sown too early for the target grazing period.

If following a cereal crop, the seed can be broadcast (by the combine or onto stubbles) into the standing crop before harvest. Direct drilling can also be used and improves the retention of soil moisture. Sow seeds to a maximum depth of 10mm to ensure uniform germination and roll after sowing. A key advantage of not cultivating the land is that it produces a firmer surface for grazing that is less prone to poaching.

Seek advice from a qualified agronomist to ensure pests, such as flea beetle, diamondback moth and slugs, are controlled. Aim to control weeds in the previous crop or by applying a pre-emergence herbicide after drilling.

Brassicas respond well to good soil fertility and are particularly responsive to nitrogen and phosphorus. Guidance on nutrient management of forage brassicas is available in Section 3 of the **AHDB Nutrient Management Guide (RB209).**

Fodder beet

Fodder beet is not a brassica, it is in a similar family to sugar beet. Like kale, it needs to be drilled in the spring. It can, however, be grazed in situ or lifted and sold, including to anaerobic digestion plants, and provides greater flexibility.

Fodder beet can produce 80–90t FW or 15t DM with a metabolisable energy (ME) of 12–12.5MJ. It does need careful management and agronomy to ensure good yields.

More information on growing and grazing brassicas can be found in **AHDB Using Brassicas for Better Returns** manual.

Table 5. Summary of sowing and feeding times for a range of forage crop types

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Swedes	Sowing												
	Feeding												
Kale	Sowing												
	Feeding												
Stubble turnips	Sowing												
	Feeding												
Grazing turnips	Sowing												
	Feeding												
Rape/kale hybrid	Sowing												
	Feeding												
Forage rape	Sowing												
	Feeding												
Fodder beet	Sowing												
	Feeding												

Note: Sowing date will vary based on location, with areas in the south being able to sow earlier in the spring and sow later in the autumn.

Cost considerations: forage crops

As with all crops, understanding production costs is crucial to ensure the profitability of the enterprise. Some guidance on estimated yields and growing costs is available in Table 6.

Table 6. Forage crop production

	Sowing rate (kg/ha)	Days to grazing	Number of grazings possible	Summer/ winter use	Dry matter %	Digestibility (D-Value)	ME (MJ/kg DM)	CP (% DM)	% Utilisation	Average DM yield (kg/ha)	Growing Cost (£/ha**)
Swedes[1]	1.00	170–250	1	Winter	11–13	87	12–13	10–11	80	8,000	482
Kale[2]	6.25	150–220	1	Both	15–17	80	10–11	14–17	80	9,000	465
Stubble turnips[2]	5.00	60–100	1	Both	12–5	85	10–11	17–18	80	6,000	319
Grazing turnips[1]	5.00	60–100	2+	Both	12–5	75	10–11	17–18	75	3,000 (+2000 regrowth)	487
Rape/kale hybrid[2]	6.25	90–110	2*	Winter	12–5	80	10–11	18–19	80	6,000	313
Forage rape[3]	6.25	90–110	2	Both	10–12	80	10–11	19–20	80	4,800	244

Notes: Drilling methods are indicated as follows [1]precision sown, [2]drilled and [3]broadcast. *Take care when sowing early as this is a vigorous crop and if not grazed will bolt. **Variable cost of growing includes cultivation, seed bed preparation, seed, fertiliser and sprays (SAC, The Farm Management Handbook 2015/16).

Case study: outwintering dairy heifers on brassicas

Farmer: John Millington
Farm: Hardwick Farm, Staffordshire

John has a 550 head milking herd based on two units, two miles apart on mainly heavy clay soils. First-year heifers now out-winter and graze the heavier land because they are lighter on their feet.

John uses a range of options between the arable and livestock systems to support this out-wintering. Stubble turnips are planted as a forage crop, followed by high-quality grass for at least six weeks leading up to service of the first-year heifers and fodder beet for the second-year heifers. On average, around 3.2ha of stubble turnips are grown for 100 first-year heifers.

Silage is also used to supplement the feed, with a 60:40 ratio of fodder crop to silage (on a DM basis) in the youngstock diet. One or two bales of silage, depending on dry matter, positioned in the field for each day of strip grazing.

Heifer weights are monitored over the winter to make sure that they meet the target weights at the end of the winter or for calving. John has found that the out-winter system has improved the health of his heifers, particularly with less pneumonia.

John says, "I made substantial financial savings by outwintering my Jersey x Friesian dairy replacement heifers, with knock-on benefits to animal health."

The costs of housing a heifer are £1.20 per head per day over winter (silage feed), when compared to £0.89 per head per day to over-winter outside on forage crops. This means that the out-winter system saves 31p per head per day. Based on 100 heifers and a 100-day winter, this is a saving of £3,100 for Hardwick Farm.

AHDB Dairy has produced several articles on best practice in heifer rearing.

Opportunity: maize

Figure 14. Maize can be an effective crop to grow in the rotation

Maize can be an effective crop to grow in the rotation, because there are several markets for maize silage (eg anaerobic digestion plants, dairy or beef farmers). It is an expensive crop to grow, however, so a market needs to be guaranteed before it is drilled, especially as a clamp will be needed.

Where to grow maize

Not all parts of Great Britain are suitable for growing maize. Farm location, soil type, altitude and field aspect must be carefully considered before deciding if and where to grow it.

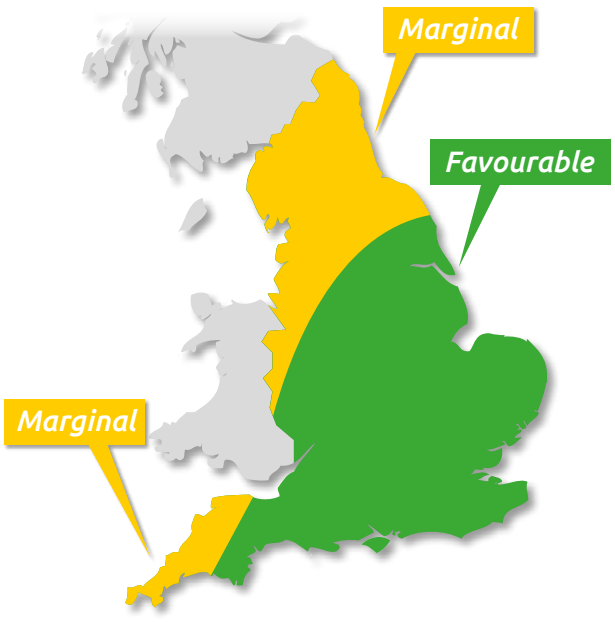

Figure 15. UK map to illustrate favourable and marginal areas for growing maize

The majority of England is suitable for growing maize for silage; only areas in the far north and the wetter, more exposed west are regarded as 'marginal'. Maize can also be grown successfully west and north of the lines shown in Figure 15. In such areas, special steps have to be taken, such as drilling maize under plastic to encourage germination. Choice of maize variety is crucial because this affects harvest date, starch content and growing needs.

Maize is a high-risk crop for soil erosion because the soil is left exposed for weeks before the crop establishes. The crop is also harvested in autumn with heavy machinery, which can damage the soil structure. Selecting appropriate fields is crucial to manage this risk of diffuse pollution.

A maize plant needs heat to reach maturity. Crop heat units (also known as Ontario heat units) are calculated with equations using maximum and minimum air temperatures. Online heat unit calculators are available. Maize should not be grown in areas that receive fewer than 2,100 heat units. Fields that achieve between 2,100 and 2,200 would be deemed marginal, while any above 2,200 are deemed favourable. Aspect and altitude will affect the air temperature and heat the plant can receive.

Maize does not like heavy, wet soils because they take a long time to warm up in spring, which shortens the growing season. Harvesting in autumn can also be a problem on heavier land. Growing maize in light soils increases erosion risk, therefore medium-textured soils are best. Undersowing can also be considered for maize (eg with clover).

More details on how and when to drill maize can be found in the **AHDB Growing and feeding maize silage** manual.

Cost considerations: maize

In 2014, maize cost in the region of £1,200/ha to grow, including a rental value of £250/ha*. Example costings for maize silage and maize silage sown under plastic, compared with grazed grass and grass silage, are shown in Table 7.

Table 7. Example costings for maize silage and maize silage sown under plastic compared with grazed grass and grass silage

	Grazed grass (ten-year ley)	Grass silage – three cuts (seven-year ley)	Maize silage	Maize (plastic)
Yield of fresh matter (t/ha)	58	50	42	52
Typical dry matter content of crop (%)	18	25	30	30
Yield of dry matter (t/ha)	10.4	12.5	12.6	15.6
Establishment costs (£/ha)				
Ploughing	55	55	55	55
Cultivations	70	70	70	70
Sowing	30	30	45	45
Seed	175	175	175	175
Lime	60	60	60	60
Fertiliser[1]	55	55	209	209
Sprays	26	26	45	45
Fertiliser applications	10	10	20	20
Spraying	12	12	24	24
Additional cost of plastic				297
Total	**49[2]**	**70[2]**	**703**	**1,000**
Additional annual costs (£/ha)				
Fertiliser[1]	196	363	0	0
Sprays	10	10	0	0
Fertiliser applications	60	60	0	0
Spray applications	12	12	0	0
Harvest and sheets etc	0	420	170	170
Rent	250	250	250	250
Total annual cost £ per ha (£/acre)	**577 (234)**	**1,185 (480)**	**1,123 (454)**	**1,420 (575)**
Cost per tonne of DM	**55**	**95**	**89**	**91**

Notes: [1]Purchased fertiliser price assumptions: N=85p/kg, P=66p/kg, K=45p/kg. [2]Total establishment costs divided by ley duration.
* Figures produced by John Morgan, Creedy Associates

Maize grain

In southern England and the Midlands, maize grain is increasingly being grown for crimping or whole cob maize, also known as ground ear maize (GEM). This is ensiled to feed as a concentrate, either conventionally combined with a maize 'header' or the whole cob foraged through a forage harvester.

Whole-crop silage

Whole-crop silage can be an alternative to maize in marginal areas. It will be harvested earlier, which provides more options. Clamps, heaps or in-field wrapped storage can be utilised. More information can be found in the **AHDB Cereals Directory.**

Opportunity: outdoor pig production

Figure 16. Outdoor sow

Outdoor pig production accounts for over 40 per cent of the total UK sow herd, with pigs reared and finished outdoors in addition to this figure. Commonly, outdoor weaned pigs continue to be reared in outdoor accommodation. In some cases, the rest of the finishing period is also completed outdoors, either in tents or in open paddocks, often commanding a premium for the product.

A range of options for pig production is available to arable businesses, linked to a high demand for quality and suitable land. Outdoor pig production systems can work well in an arable rotation and increase soil health, structure and fertility.

Business options

A breeding unit requires land on a two-year rotation. Land with good, free-draining sand will command good rental returns.

The rearing and finishing of outdoor pigs is becoming a growing opportunity, because they are based on shorter term arrangements and fit in best with crop rotations that include hungry root crops or maize (since manure helps to feed them).

Muck-for-straw deals are also common, with the pig unit often able to help speed the process of straw removal from the fields in summer and the arable staff able to move the manure in the winter months, when their workload reduces.

Various agreements exist between landlords and tenants, from simple rental of the land, to working partnerships. Some larger pig production companies provide start-up opportunities for new entrants and, in return, are paid a management fee for the number of pigs produced.

The introduction of outdoor pigs is an opportunity to bring a new enterprise to the farm's business portfolio, with a high demand for outdoor born and reared pig meat and support readily available from already established pig producers.

Better training and understanding has seen some businesses work together with potential landlords to establish grass leys in the rotation, before the pigs. Alternatively, outdoor pigs can be used following root and vegetable crops to forage. This helps to remove any missed cropping and the pigs assist in cleaning the field.

Benefits of this complete outdoor pig system include:

- Weed control
- Pest and disease control
- Soil fertility, health and structure improvements
- Additional income from the livestock
- Opportunities for environmental improvement (eg land around the pig sites can be put down to grass margins or pollen and nectar mixes)

Cost considerations: outdoor pigs

The rental income from outdoor pigs is closely linked to the quality of the land provided. The additional provision of a secure yard and access to mains electricity can provide significant returns.

Water is a must for any livestock enterprise and should be taken into account for any potential land rental. The increasing regulation of water supplies often means the tenant is responsible for approaching the local water company to secure a water supply for the rental period. However, if the landlord is able to provide a supply from their own source, this can add to the potential rental figure.

Taking into account the factors discussed above, current returns can range from £300/ha to over £400/ha. With an average outdoor breeding unit of 1,000 sows requiring 40ha, potential income can be very profitable when measured against other cropping incomes. In addition to this figure, there is also the potential improvement to soil fertility, health and structure. These benefits can last for up to three years after the pigs have gone.

Figure 17. Consider fencing and water availability for outdoor pig production

Case study: outdoor pig production

Farmer: Chris Fogden
Farm location: Fogden Farms, Suffolk

Chris farms a herd of around 1,200 outdoor sows on a large estate in Suffolk. He rents land for two years as part of a rotation. The pigs provide a valuable rotation break from the various crops grown on the estate, which include root crops, onions and maize. On the estate, the pigs have been able to provide valuable fertility and health back to the very sandy soils. The estate is at the forefront of environmental management and, using a variety of cropping methods – including the pigs – has seen big benefits, not just to the soils but also to the surrounding area, including an increase in bird species and other wildlife.

Opportunity: manures

Livestock manures are an excellent source of valuable nutrients and organic matter. They can provide more than adequate amounts of phosphorus and potassium and reduce nitrogen fertiliser bills.

Figure 18. Consider the financial value of manures

Key to the success of using manures is to integrate them fully into nutrient management plans. It is critical that manures are used in the way that best fits crop requirements and then to only top up with bagged fertiliser if necessary.

The amount of nitrogen available to a crop increases in the spring. Applying manures at this time of year supplies nutrients when crops need them the most and reduces the risk of nitrate leaching.

The financial value of the nutrients contained in manures is relatively easy to calculate. Typical values based on average nutrient content, taken from the **AHDB Nutrient Management Guide (RB209)**, are shown in Table 8. It can be harder to quantify the value of the organic matter, but research has shown that regular addition of manures, especially farmyard manure, improves soil structure, workability, water infiltration and drainage. For further information on soil management, visit **ahdb.org.uk/greatsoils**.

Table 8. Typical financial value of livestock manures

Manure	Application rate	Available nitrogen (kg N/ha)	Total phosphate (kg P_2O_5/ha)	Total potash (kg K_2O/ha)	Total value of N, P and K
Cattle farmyard manure (fresh)	20t/ha	18	64	188	£142/ha
Pig slurry (4% dry matter)	50m^3/ha	108	75	110	£191/ha
Poultry manure (40% dry matter)	6t/ha	46	72	90	£127/ha

Note: The values assume that the manure is spread in the spring on to a medium soil at P and K Index 2 and incorporated within six hours. Purchased fertiliser price assumptions: Nitrogen (N)=85p/kg, Phosphate (P)=66p/kg, Potash (K)=45p/kg.

Figure 19. A screenshot from AHDB 'How to sample manure' video

Average nutrient content values in the **AHDB Nutrient Management Guide (RB209)** are accurate but analysis of your manure is advised. Further information is provided in a short video at **ahdb.org.uk/rb209**

Good manure management

When planning the use of manures, there are some key practical points to consider to ensure full financial value is gained:

- Don't waste money on bagged fertiliser, take account of the nutrient content of livestock manures and only top up with fertiliser when needed

Find out the nutrient value by sending a sample to a laboratory for analysis or use the average values published published in Section 2: Organic materials of the **AHDB Nutrient Management Guide (RB209)**.

- Create a manure management plan to identify fields or parts of fields where spreading restrictions apply. Most assurance schemes require you to create a manure management plan
- Maximise availability of nutrients by applying manures in the spring and incorporate them as soon as possible
- Track levels of soil organic matter by asking the laboratory to test it for you when you send in a soil sample for routine analysis (P, K, Mg, pH)

The environmental impact should also be considered. Poor manure management can cause nutrients and other pollutants to get into watercourses or escape as harmful gases. This can happen a variety of ways:

- Runoff: when rainfall does not infiltrate into the soil, instead it runs across the surface and carries nutrients and soil into watercourses
- Leaching: when soluble nutrients, such as nitrate, pass through the soil and into watercourses as water drains
- Ammonia volatilisation: when nitrogen in manures is converted into ammonia gas, ammonia is initially lost to the atmosphere but is then deposited on the soil or into watercourses

When nutrients, such as phosphate and nitrate, enter watercourses they can cause algae and plants to grow rapidly and then die when the environment becomes overcrowded. This can lead to oxygen depletion and the watercourse to become lifeless.

Ammonia can affect public health as well as causing acidification of soil and watercourses.

Muck-for-straw deals

Exchanging muck for straw can be a convenient arrangement whereby bedding straw is provided for the stockperson, who returns an enhanced product rich in nutrients and organic matter.

Agreements between farmers can vary significantly and it is well worth clarifying how much straw and muck will change hands and who will pay for or carry out baling, transportation and spreading.

The approximate value of straw and farmyard manure, based on average nutrient content taken from the **AHDB Nutrient Management Guide (RB209)**, is presented in Table 9. However, while soil improvement provided by farmyard manure adds extra value to the material, it is not so easily quantified.

Table 9. Approximate value of straw and farmyard manure

Nutrient content	Fresh weight	Phosphate and potash content	Financial value
Winter wheat straw	1t	6kg P_2O_5/t 48kg K_2O/t	£26
Cattle FYM	1t	1kg N/t 3kg P_2O_5/t 9kg K_2O/t	£7

Figure 20. Consider using manure in a muck-for-straw deal

Further reading

This publication refers to a wide range of resources that can accessed via **cereals.ahdb.org.uk/livestock**

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