Establishing and growing clover

Contents

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Introduction

The cost of production per kilogram of liveweight gain or litre of milk is a major consideration for all livestock producers. One of the best ways to improve efficiency and increase profitability is to produce more feed on the farm, rather than buying it in.

While feed and fertiliser prices remain high, having a dependable source of homegrown protein, such as clover in the fields, offers some protection from ever-rising input costs.

Whether grazed or conserved, white and red clover both provide a good source of protein in ruminant diets and have high intake characteristics. Clover plants also fix nitrogen (N), so there is an added benefit of less artificial N fertiliser being required for grass growth.

Clover-rich swards fit well into forage or arable rotations and benefit soil fertility and structure.

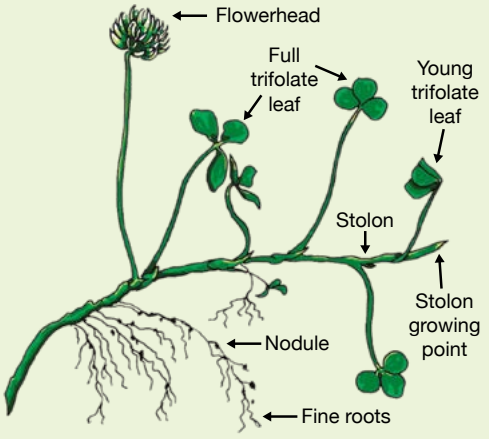
This manual outlines the advantages of including clovers in the farming system and the management needed to optimise success.

Siwan Howatson
Grass and Forage Scientist

White clover

Top tips

- Aim for 30% clover content of sward
- Choose a leaf size according to the class of animal and whether the ley is going to be short, medium or long term



White clover is a perennial legume. It suits both grazing and silage and can increase yields by up to 15%, depending on clover content and N inputs. The key to its survival and production potential is its multi-branched creeping stem, called a stolon, which provides sites for new leaves, roots and flowers. The stolon also stores carbohydrates and proteins, meaning the plant can overwinter and regenerate in spring.

Why use white clover?

1. Nitrogen fixation

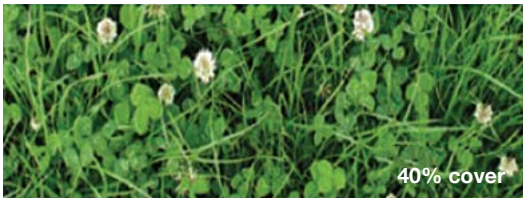
Bacteria living in nodules on clover roots convert N from the air into nitrates. These stored nitrates are released to the surrounding plants and following crops through root decay and the new roots and nodules that grow to replace them.

In a well-balanced and stable grass/clover sward (20–30% clover), the potential N supply generated through the fixation process is equivalent to 180 kg N/ha.

It is often difficult to decide how much N will be supplied because clover content can change from year to year and within a given season. The photographs below show how to estimate clover content and assess N supply. These figures should be used as rough guides only: full clover development does not normally take place until late spring onwards.

180 kg N/ha

240 kg N/ha



300 kg N/ha

2. Feed value

White clover has high nutritional value and, compared with grass-only swards, is particularly rich in protein and mineral content. Livestock find white clover very palatable and digestibility is high because there is continual renewal of leaves and little stem development. This helps maintain dry matter intake (DMI) throughout the season.

For every 10% increase in the amount of clover in the sward, the crude protein (CP) content of first-cut silage increases by 1%.

Assuming equal access, livestock may consume 20–30% more white clover than grass, which will increase liveweight gains and milk production.

3. Soil structure

White clover's deeper taproot system can help tackle soil compaction. It causes more gaps between soil particles, which enhances movement of nutrients and water and improves crop yields.

Research shows that where clover is used, soil have better structure and crops can use fertiliser more efficiently.

For more information on assessing your soil structure, see the ***Healthy grassland soils*** factsheet, available at **ahdb.org.uk/knowledge-library/healthy-grassland-soils-2**

4. Different growth pattern

Clover starts growing when the soil temperature is 8°C, as opposed to 5°C for grass, which means it has a different growth pattern.

Clover is particularly valuable during the mid to late season when grass growth starts to fall away (see Figure 1).

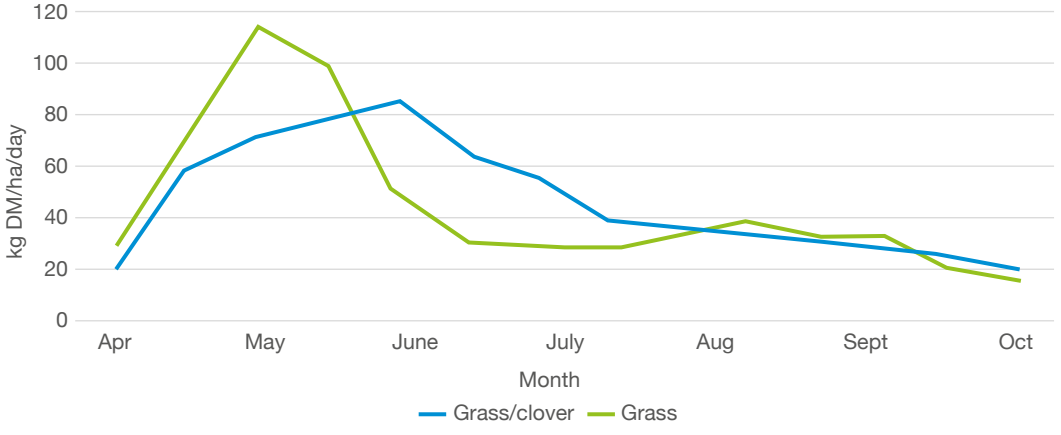


Figure 1. Grass growth curve pattern

How to use white clover

Varieties

By selecting under various field conditions, clover breeders have developed clover varieties that are compatible with new ryegrasses according to their role in a mixture.

The type of clover sown depends on the intended use of the ley. Leaf size is closely related to the size of the stolon's and dictates the livestock system for which it is most suited, as shown in Table 1.

Table 1. White clover leaf size and uses

Leaf type	Leaf area* (mm^2)	Uses
Small	<700	Continuous, hard sheep grazing
Medium	700–1,000	Rotational sheep grazing Continuous cattle grazing Frequent cutting
Large	>1,000	Cutting Rotational cattle grazing

*See ***Recommended Grass and Clover Lists***

White clovers are categorised by leaf size. Larger-leafed varieties tend to be higher yielding, but are less tolerant of grazing and compaction. If selecting varieties for cutting, choose large-leafed varieties for maximum yield. If selecting for cattle grazing, choose medium leaf sizes and for sheep grazing choose small-leafed varieties.

Grass/clover mixtures

Mixtures produce scientifically proven yield benefits compared with the same varieties sown individually.

White clover has been selected to withstand being grazed or cut, so the choice of companion grass depends on the primary use of the sward, i.e. grazing or cutting.

Typically, the ideal grass is ryegrass because it has good N use efficiency. This means it can successfully convert the nitrates produced by the clover into yield.

Grasses such as fescue, meadow grass and Yorkshire fog, have lower N use efficiency, so if production is the main objective, they do not make good companion grasses.

The large European Union-funded MULTISWARD project found that by including deep and shallow rooting, N-fixing and N-lifting species, yields and animal performance were higher than in pure ryegrass swards receiving considerable N fertiliser inputs. The project, carried out across Europe, found that swards with two or three legumes in mixtures with perennial ryegrass receiving 150 kg N/ha, performed as well as monoculture ryegrass swards receiving 300 kg N/ha.

The multispecies swards including clover promoted higher forage intake across all livestock and increased output per hectare.

With clover also being an increasingly important source of N on farm, an AHDB-funded trial sought to find the most suitable companion grass species for white clover. At under 200 kg N, clover still accounted for 29–53% of annual DM yield.

Clover dominance

If clover becomes dominant throughout most of the season and little grass is visible, it can unbalance the sward. This may increase weed infestations because there is less ground cover during late autumn, winter and early spring, when clover growth has slowed or stopped.

If clover dominance is a problem:

- Graze more intensively, particularly with sheep
- Use tactical applications of N to stimulate grass growth so it can outcompete the clover
- Avoid regular silage cutting because the offtake of N and light penetration on the growing points encourage clover growth
- Consider using clover varieties with smaller leaves in future

The growth habits of different grass species appear to dictate clover patterns and when established with late-heading timothy, clover contribution was highest, as shown in Table 2.

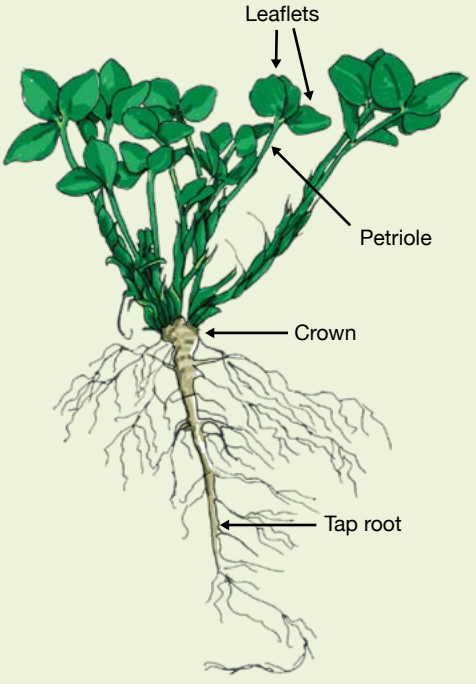
Table 2. Impact of companion grass on white clover yield and contribution under silage management

Companion grass	Grass + clover yield (t DM/ha)	Clover yield (t DM/ha)	Clover contribution (%)
Cocksfoot	13.9	4.0	29
PRG	13.9	5.9	42
PRG (T)	13.9	6.4	46
Timothy	13.8	7.4	53

(T) = Tetraploid cultivar

Red clover

Red clover is a perennial legume that lasts for 2–4 years, with newer varieties lasting 4–5 years. Unlike white clover, it has an upright growth habit and a strong, deep tap root.



The crown, located at the base of the stem, acts as a store for nutrients. Differences in the size and storage capacity of the crown affect the persistency and suitability of different red clover varieties for particular management regimes.

Why use red clover?

Nitrogen fixation

Like white clover, bacteria in the nodules on red clover roots convert N from the air into nitrates. These stored nitrates are released to the companion plants and following crops through root decay and the new roots and nodules that grow to replace them.

Red clover tends to fix between 150–250 kg N/ha per year.

High yields

Red clover/ryegrass swards are capable of producing 10–14 t DM/ha per year.

Break crop

Red clover has considerable benefits as a break crop in mixed farming situations. This is thanks to its ability to improve soil structure and soil N status.

Organic production

Red clover is a key forage and soil fertility-building crop for organic farms.

Feed value

Protein content is particularly high in red clover and is protected, so less protein is lost from silage, as shown in Table 3. Less protein breakdown of red clover silage is a result of the action of the enzyme polyphenoloxidase (PPO), which increases the quality of the protein.

Depending on the laboratory method used, feed value is often greater than it appears in silage analysis. The use of wet chemistry is the most accurate method of determining protein content.

Table 3. Nutritional value of average grass and red clover silage

Nutritional value	Average grass silage	Average red clover silage
Dry matter (%)	26–34	25–30
D-value (%)	65	60–70
Metabolisable energy (ME, MJ/kg DM)	10.5	9.8–11.4
Crude protein (%)	12	14–19
pH	<4.5	4.0–4.5
Ammonia (% N of total N)	7	<5

Source: Adapted from ADAS and IBERS

How to use red clover

Red clover swards are usually grown for high protein silage production, with aftermath grazing in the autumn. The development of more persistent varieties that are more tolerant of grazing is creating potential for red clover to be used in cattle rotational grazing systems.

Red clover is primarily grown in a mixed sward, but can also be grown as a monoculture.

Italian, hybrid and perennial ryegrasses are possible companion grasses. In arable rotations, a common option is to use cutting grasses, such as Italian or hybrid ryegrasses, which produce a high yield in the first two years, but should then be replaced. Typically, for white and red clover, it takes around one year for the quoted levels of N to be fixed: up to 150 kg N/ha for white clover and up to 250 kg N/ha for red clover. Therefore, they can be difficult to justify in a short-term ley and longer-term leys (up to 5 years) should be considered.

Advantages of growing red clover with a companion grass are:

- Reduced impact of poaching
- Improved nutritional balance, especially with grasses that have high sugar (water-soluble carbohydrate) content
- Utilisation of fixed N by the grass. Compared with monoculture, N loss can be reduced four-fold when red clover is grown with companion grasses

Table 4. Example mixture for 4–5-year ley for silage and autumn grazing

Type	Seed rate
Intermediate heading perennial ryegrass (diploid and tetraploid)	20.0–24.0 kg/ha (8.0–10.0 kg/acre)
Red clover	7.5 kg/ha (3.0 kg/acre)

Case study

Using red clover to produce high-quality silage and finishing lambs

Andy Crane, Devon

Andy farms 900 acres in an organic system, where he lambs 750 ewes and calves 90 suckler cows. Ewes are housed at scanning, then turned out after lambing in March/April. Most cattle are housed in November and turned out in spring. A small group of Gelbvieh heifers are outwintered on severely disadvantaged (SDA) ground with supplementary forage. Lambs are finished extensively on red clover aftermaths and kale. Cattle are finished on red clover silage, wholecrop silage and crimped barley.

In recent years, Andy has increased the area of red clover on the farm. This serves many purposes, including providing high-quality silage for growing cattle and in-lamb ewes and grazing for lambs. The red clover grows in a mixture with tetraploid ryegrasses. Andy says, "We aim to produce a silage with metabolisable energy (ME) of 11+ MJ/kg dry matter (DM), with a crude protein content of 15–20%." Recommendations for making red clover silage are to leave a stubble length of 7–8 cm and chop the crop. Andy added, "Cut when clover is in the late bud stage for high protein content. Setting the mower to the right height is important so you don't cut too low and damage the plant, which will shorten the longevity of the crop. Typically, the leys last for four years on our farm, producing two to three silage cuts per year. To maintain the protein quality, do not ted and wilt for a maximum of 48 hours."

Red clover silage is clamped and baled on the farm, with second and third cuts usually baled and fed to the in-lamb ewes. Ewes are supplemented with concentrates six weeks pre-lambing, with no supplementation post-lambing. After 2 days, ewes are turned out to graze on a mix of white and red clover with ryegrass. Andy says, "Using red clover has reduced bought-in feed costs on the farm for both the sheep and beef enterprises. It has also increased growth rates for cattle and lambs, with lambs achieving liveweight gains of up to 250 g/day. We continue to graze the clover through December because our land has good drainage and stocking densities are low – 60% of the lambs are sold by then, so poaching isn't a problem. It is also an ideal forage to finish lambs on because the parasite risk is minimal."

Establishing clover

White clover

In a rotational system, grass/clover leys may follow cereals, roots or brassicas; these crops reduce N levels in the soil, which encourages clover establishment. Establishment options include direct drilling, broadcasting, hoof and tooth and undersowing.

Sowing essentials

- A clean, firm seedbed, ring-rolled prior to sowing
- Soil pH of 6.0–6.2. If ground conditions permit, apply lime 2–3 weeks before spring N application to fields destined for silage because it can take several months to increase pH throughout the topsoil
- Clover is particularly sensitive to N application during establishment. Do not apply N during this period
- Apply up to 50 kg N/ha and phosphate (containing phosphorus, P) and potash (containing potassium, K) if soil indices are below 2
- The optimum seed depth is 5–10 mm
- Broadcasting is the most reliable method of establishing a clover-based sward

Timing

Clover should be sown into a warm soil between April and August. Stolon production must start before winter.

Seed rate

In mixtures, aim for a clover seed rate of 1–4 kg/ha (0.5–1.5 kg/acre).

Introducing white clover into existing swards

This can be done by:

- Slot seeding/direct drilling
- Broadcasting following scarification
- Hoof and tooth, i.e. using animals to trample seed in and graze grass tight, if 20–40% bare soil is visible

Broadcasting clover seed

Top tips

- Minimise competition from existing plants before sowing by heavy grazing or harrowing to open up the sward
- Ensure soil is sufficiently disturbed to allow seed-to-soil contact and coverage
- Sow when grass is least vigorous; for example, after flowering in July, as long as there is sufficient soil moisture. After a silage cut also offers a good opportunity
- Use a higher seed rate (4.0 kg/ha or 1.5 kg/acre) than conventional sowing to compensate for greater seedling loss
- Lower seed rates (2.5 kg/ha or 1.0 kg/acre) may be used for a periodic top-up in long-term swards
- Use slug pellets
- After sowing, graze hard in short, intensive 3–4-day periods every month, until clover is well established, to reduce competition from other plants

Coated seed

Some seed merchants supply white clover seed that has been coated with a material to absorb water and aid establishment. It is also inoculated with rhizobia (bacteria that fix N). Research has shown that rhizobia must be matched to the variety to derive maximum benefit from using inoculant in coated seed.

Red clover

Red clover can be drilled, broadcast, or undersown to an arable silage crop in April. It can also be introduced into an existing sward.

Sowing essentials

- A clean, firm seedbed, ring-rolled prior to sowing
- Soil pH of 6.0–6.2. If ground conditions permit, apply lime 2–3 weeks before spring N application to fields destined for silage because it can take several months to increase pH throughout the topsoil
- Apply N fertiliser on soils with low N status, but only up to 50 kg N/ha
- Apply phosphate and potash if soil indices are below 2
- The optimum seed depth is 5–10 mm

Timing

- Sow into warm soil from April to late July

Seed rate

- For monoculture swards, use 15 kg/ha (6 kg/acre)
- For mixed swards, use 7 kg/ha (3 kg/acre) of red clover and 22 kg/ha (9 kg/acre) of grass

Under the greening rules of the Common Agricultural Policy (CAP), a monoculture or mixture of legumes can also be grown on farms with more than 10 ha of arable cropping.

MULTISWARD project

Researchers across Europe are exploring the benefits of using multispecies mixtures that will improve livestock performance.

In the MULTISWARD project, ryegrass, tall fescue or chicory were compared with swards containing two grass species and around 33% legume (white clover or red clover).

Under both cutting and grazing management at all sites, the swards containing red or white clover outperformed yields of grass in monocultures at the same N fertiliser level and produced the same yield as the high N grass monocultures.

Animal intake and milk yield were compared between swards containing perennial ryegrass only and a mixture of four species: perennial ryegrass, white clover, red clover and chicory, at two different N levels. The multispecies sward promoted higher forage intake across all livestock and better output per hectare.

Dealing with weeds at establishment

Here is an establishment method to help achieve weed-free grass/clover swards.

- Maintain soil fertility to ensure that grass and clover can be competitive against weeds
- Use glyphosate to kill off the old ley and any weeds
- Sow into a clean seedbed to avoid competition from weed species during establishment
- Sow the new ley without clover
- Monitor the new ley and treat any weed problems before clover is introduced
- Stitch or broadcast clover into the established sward from six weeks after weed control
- Most weeds in reseeds can be controlled by management, e.g. grazing or topping, and do not need herbicides

If herbicides are needed after the clover is sown, use a clover-safe product. Only spray if clover plants are vigorous and well developed. It is recommended to use a weed wiper to treat target weed species only and to involve a BASIS-trained adviser. As part of the Sustainable Use Directive, anyone using sprays on farm must have an appropriate certificate and equipment (except knapsack sprayers) must be tested.

Complying with spray legislation at a glance

These measures apply to grassland weed killers:

- Demonstrate that integrated pest management (IPM) is followed on your farm
- The sprayer operator on your farm must hold a recognised certificate. Grandfather rights are no longer valid
- All pesticide application equipment (except knapsack sprayers) must have a valid National Sprayer Testing Scheme (NSTS) certificate

These measures are a legal requirement for UK farmers through the UK's Sustainable Use Regulations. Noncompliance could lead to prosecution and threaten your Single Farm Payment. They will also feature in Red Tractor standards.

Think water: keep it clean

Many grassland weedkillers are detected in drinking water sources. Take extra care to protect water when filling and washing the sprayer and avoid over-spraying near ditches and streams.

In an organic situation, establish clover into stale seedbeds. Prepare the seedbed for planting a sufficient number of days before drilling to let the weed seeds germinate and emerge. When soil moisture allows germination, subsequent flaming, harrowing or drilling will eliminate many of the germinating weed seeds.

Undersowing

Undersowing crops with clover or grass can help maximise production per hectare and is a good way to establish leys. Spring-sown cereals are ideal for undersowing because they are less dense than winter-sown crops like winter wheat. Cereal varieties should be early-maturing and resistant to lodging. Barley is preferred because it is less competitive than triticale or oats. Open canopy crops, such as brassicas or potatoes, can also be successfully undersown and aid pest and weed control.

Top tips

- Sow the clover or grass on the same day as the cover crop
- Cereal sowing rate should be reduced by one third
- Open canopy crops can be sown at their usual sowing rate, with the clover or clover/grass mix sown at normal rate
- Approximate rate recommendations for undersowing cereal with clover:
  - White clover alone – 4.0 kg/ha (1.5 kg/acre)
  - White clover with ryegrass – clover, 2.5 kg/ha (1.0 kg/acre) and ryegrass 29.5 kg/ha (12.0 kg/acre)
  - Red clover alone – 12–14 kg/ha (5–6 kg/acre)
  - Red clover with ryegrass – clover, 7.5 kg/ha (3.0 kg/acre) and ryegrass 19.0 kg/ha (7.5 kg/acre)

Benefits

- Reduced N leaching
- More available N for successive crop
- Quick establishment of grazing ley
- Reduced cultivations
- Less weed pressure

Potential drawbacks

- Undersown crops may compete with the cover crop; most likely where there is a high proportion of ryegrass
- In wet years, the undersown crop may become more green and vigorous, making harvesting difficult
- If it does not get enough sunlight or nutrients, the secondary crop may not establish as well as it would if it had been drilled after harvest of the main crop
- At high fertiliser rates, undersown clover alone can increase nitrate leaching
- There may be implications for fungicide and pesticide applications

For more information, see ***Opportunities for cover crops in conventional arable rotations***, available online at **ahdb.org.uk/cover-crops**

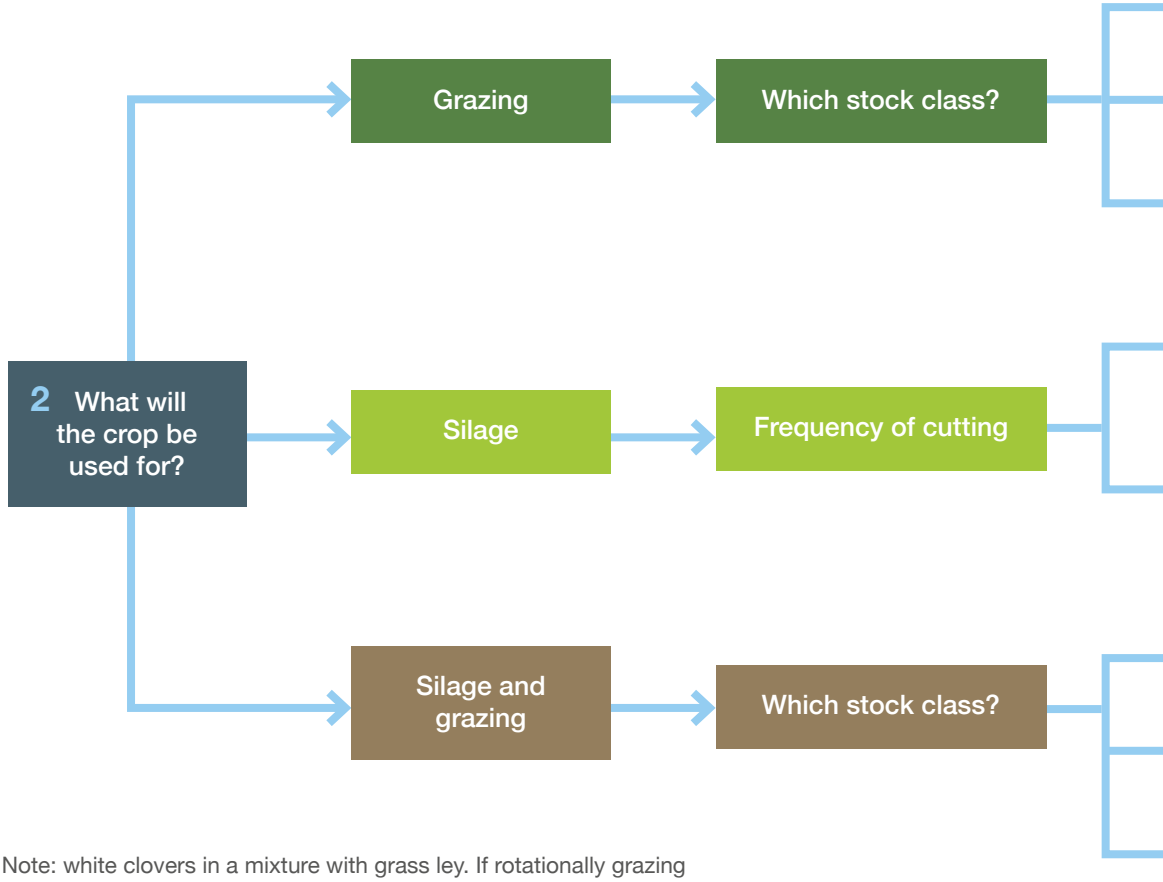
Undersowing red clover in winter wheat

What's the best type for your farm?

1 What are you aiming for by introducing clover to your farm?

- ☐ Reduce purchased N fertiliser (red and white clover)
- ☐ Improve soil structure (red and white clover)
- ☐ Improve pasture quality (white clover)
- ☐ Increase DMI at grazing (white clover)
- ☐ Maintain grazing in mid-to-late season when grass growth declines (white clover)
- ☐ Produce high protein forages (red clover)
- ☐ Use as a break crop (red clover)
- ☐ Crop for finishing stock (red clover)

You also need to consider whether you're using clover for grazing or silage and what class of stock it is for. This will dictate leaf size.



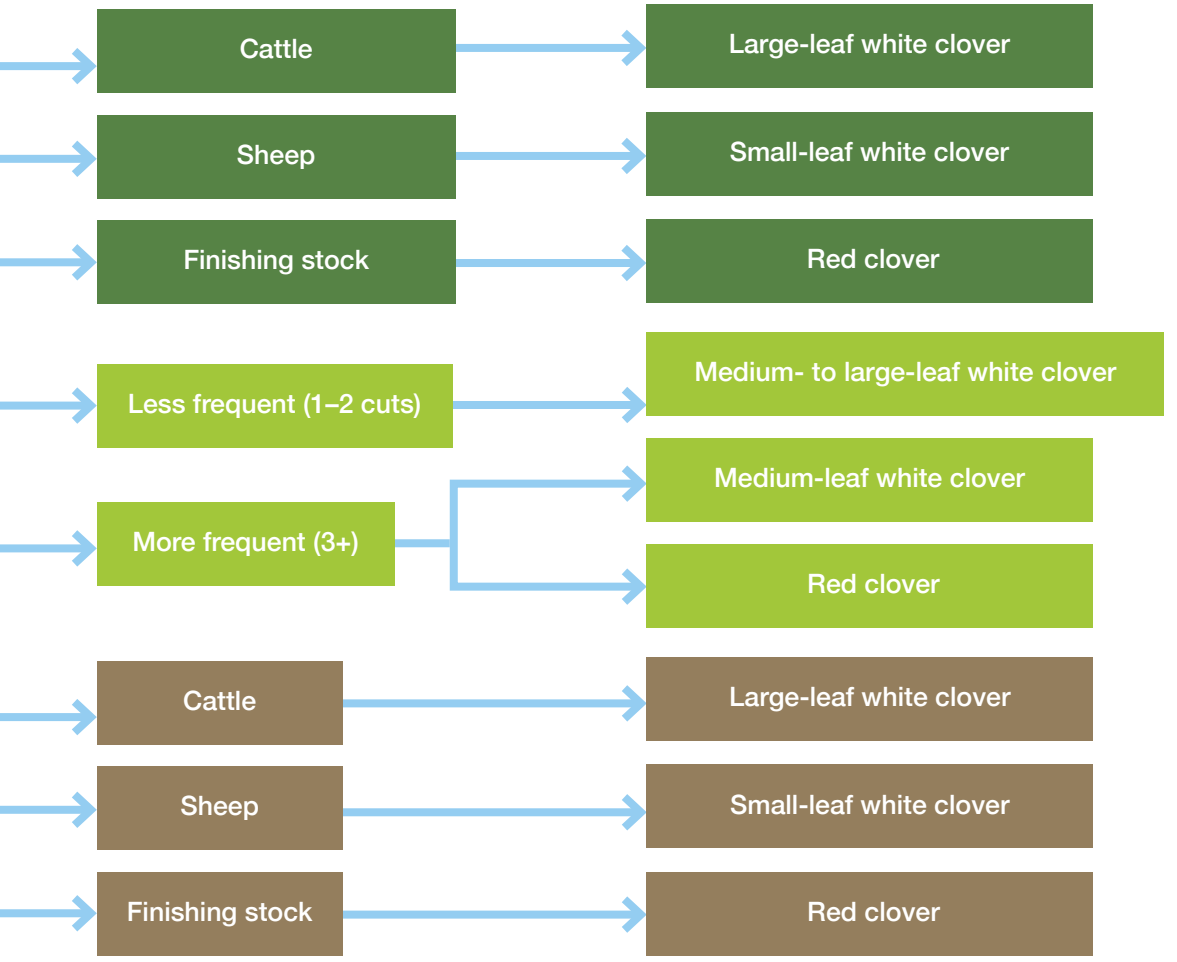
Note: white clovers in a mixture with grass ley. If rotationally grazing cattle and sheep together, choose medium-leaf white clover.

3 Choosing a mixture

When assessing mixtures, check that the varieties are listed in the ***Recommended Grass and Clover List***. Then, consider whether or not the varieties are suitable for the job. Refinements can be made to mixtures in consultation with your merchant.

The lists are drawn up after rigorous testing for yield, ground cover and quality. Research has shown that the Recommended Grass and Clover List system is representative for lower fertiliser regimes – the ranking of varieties did not change when 100, 200 and 400 kg N/ha was applied.

To order a free copy, email **publications@ahdb.org.uk** or call **024 7799 0069** or download a copy at **ahdb.org.uk/knowledge-library/recommended-grass-and-clover-lists-2020-21**



Managing white clover

The optimum amount of clover in a field is 30% of the DM of the total sward. At this level, clover can fix 180 kg N/ha/year and both animal and companion grass performance will benefit.

However, the proportion of clover growing is often overestimated because its leaf lies face up compared with grass.

To reach 30% clover, the sward must appear to have 50–60% clover at its peak growth in August.

Under rotational grazing, swards with 30% white clover content can be maintained for at least 10 years, with total sward DM yields reaching 10–11 t/ha/year.

Top tips for management

- Assess stolon growth in the spring and treat as though the stolons are weak and vulnerable
- Avoid excessive stolon damage from poaching
- If clover content is too low, do not allow grass to shade it out. Make sure it is grazed frequently, or take the paddock out of the grazing rotation as surplus before the plants gets too mature
- Keep grass at 4–6 cm over the winter to protect stolons from frost damage
- If clover content is too high, use intensive grazing or strategic N use to increase grass growth

10% clover content

30% clover content

60% clover content

Case study

Using white clover and ryegrass leys in an organic dairy system

Robert Drummond, Ayrshire

Osliebrae is home to a herd of 60 organic-Ayrshires and followers on 170 acres. The autumn-calving herd grazes in late February, through on/off grazing, until full turnout in late March through to late October/early November. It produces 3,850 litres from forage. The goal is to utilise 10 t DM/ha/year. Robert is one of 32 Forage for Knowledge contributors, who measures and monitors weekly grass growth and quality results throughout the season.

Clovers and other legumes are essential to optimise organic pasture output and quality. Together with organic manures, they are vital for building and maintaining soil fertility in the absence of artificial fertiliser. However, one size does not fit all. Robert says, "I use a variety of white clovers on the farm, from medium to smaller leaf varieties, to cope with tight grazing. The smaller-leafed varieties tend to survive better in some pastures. I have tried red clover in the past, but it doesn't survive well in this cold climate; it tends to last only two to three seasons compared with grass and white clover leys, which last 7+ years."

Usually, Robert reseeds fields after 7–8 years. The leys receive no extra seed during this time.

Robert's seed selection toolkit

- ***Recommended Grass and Clover List***
- Advice from local seed merchant
- Organic seed derogation, to include a proportion of non-organic clovers in the ley

Left to right – five-year-old red clover and ryegrass ley compared with a seven-year-old white clover ley. White clover is more suited to Rob's system

Case study (continued)

Robert says, “I choose a broad-range clover mix, predominantly sown with perennial ryegrasses. The choice of organic clover varieties is limited; however, the organic seed derogation helps so I can include a percentage of highly productive, non-organic clover in the ley. The climate in Ayrshire means I can’t sow any earlier than May because the soil would be too cold – we still get grass frosts in April. I usually plough and then put the seed in with a spring tine harrow with air-seeder. I aim to get bales from the new ley in July, then cut again or graze later in the season.”

The main benefit clover brings to Robert’s farm is its N fixing ability and ease of management. “On my farm, the N fixing ability of clover is crucial for summer growth. I also find it easy to manage: I don’t have any problems with bloat and it can cope with tight grazing, which helps to control weeds.

Tight grazing and the absence of artificial fertiliser helps to maintain the balance of clover and ryegrass in the sward, preventing either species from becoming dominant.”

Robert aims to graze until late October/early November to reduce housing and feed costs, so it is crucial to maintain a productive sward. “I assess sward growth weekly and look forward to receiving the results of the forage samples. It is interesting to see how different paddocks vary in quality. Measuring swards and making sure paddocks are at the correct pre-graze and post-graze point is a key part of rotational grazing. Having good infrastructure is crucial to extend the grazing season through to late October/early November – and the use of cow tracks has been invaluable for achieving this.” During periods of wet weather, cattle are on/off grazed to prevent damage to the ley and reduce poaching.

Managing red clover

Red clover only grows from its crown, so the plant will die if this is damaged. The crown lies above ground, so it is crucial to protect this area of the plant.

Top tips to reduce crown damage

- Height for all silage cuts is no lower than 7–8 cm
- Avoid excess wheelings from heavy machinery
- Grazing height of aftermath is maintained above 6 cm and the crop is overwintered at 4–6 cm
- Poaching by animals is minimised

For silage

- Graze swards lightly in the autumn of the sowing year
- For high protein content, cut when clover is in the late bud stage, or in early bloom for lower protein content
- Take two to three cuts (four maximum) at 6–8-week intervals after a first cut (15 May–2 June). This should yield 13–14 t DM/ha on fertile sites, or 10 t DM/ha on upland sites
- Ensile at 30% DM to minimise wilting losses
- Do not use a mower conditioner. Leave in wide swaths and wilt for up to 48 hours, turning the swath once. To reduce leaf shatter, do not ted
- Avoid crown damage by not cutting too low – aim for 7–8 cm
- Chop the crop
- Graze autumn regrowth lightly to finish lambs or cattle
- Do not apply N, except for establishment
- Apply phosphate, potash and magnesium as recommended for pure grass swards. Clover is more responsive to potash than grass, so may benefit from a small application of potash at index 2–

Red clover is naturally more aerobically stable than grass, so good silage management will produce a good end product.

For grazing

- Use aftermath to graze lambs or cattle. Compared with ryegrass, superior growth rates can be achieved from red clover (see Table 5)
- Avoid grazing in wet or damp conditions to limit bloat and reduce risk of poaching

For red clover and grass swards, there may be some advantage to applying a small amount of N (up to 50 kg N/ha) in the early spring, if the grass appears to be N-deficient.

Table 5. Lamb performance from grazed red clover or ryegrass

Lamb performance	Red clover	Ryegrass
Growth rate (g/day)	229	182
Days to finish	40	49
Eye muscle depth (mm)	27.1	25.9
Subcutaneous fat depth (mm)	4.1	3.9
Cold carcase weight (kg)	18.8	17.7
Killing out (%)	51	48

Source: IBERS

Manure and slurry

Low potash supply can restrict the growth of clover, even when there seems to be enough for grass. If the sward contains both grass and clover, then it is even more important to correct low soil potash indices. Phosphate is also critical for N fixation. Clover growth is often limited in low phosphate situations.

To decide whether and how to apply – and subsequently reapply – manure and slurry, the nutrient content should first be analysed in a laboratory using near-infrared spectrometry (NIRS). Equipment is also available for on-farm testing to give an instant assessment. In general, the thicker the slurry, the more nutrients it will contain. Typical values are shown in Table 6.

For more information on sampling, see our ***How to sample farmyard manure*** video, available on the AHDB Beef & Lamb YouTube channel and the ***How to sample slurry*** video, available on the AHDB Dairy YouTube channel.

Losses from leaching, run-off or to atmosphere mean that not all nutrients in slurry/manure are available to the plant. Losses depend on manure type, DM, application time and soil type.

For more information on the nutrient supply of livestock manures, including sulphur and magnesium, see page 17 of ***The nutrient management guide (RB209), Section 2 Organic materials***. Consult a FACTS-qualified adviser for further advice.

Slurry application

Slurry must be applied at a sufficient rate to meet the P requirement of clover and optimise contribution to a mixed sward.

When to apply

Early growth and fixation from white clover is important to achieve a balanced sward. This means that N applications in early spring should be limited – later N applications (July/August) should not be necessary in a clover-rich sward and would discourage N fixation.

Table 6. Typical values of manures (fresh weight basis)

Manure type	Dry matter (%)	Nitrogen (kg N/t)*	Phosphate			Potash		
			Total phosphate (kg P_2O_5/t)	Availability (%)	Available phosphate (kg P_2O_5/t)	Total potash (kg K_2O/t)	Availability (%)	Available potash (kg K_2O/t)
Cattle farmyard manure*	25	6.0	3.2	60	1.9	9.4	90	8.5
Cattle slurry*	6	2.6	1.2	50	0.6	2.5	90	2.3
Sheep farmyard manure*	25	7.0	3.2	60	19.0	8.0	90	7.2

*Values vary depending on the dry matter %, age of the manure/slurry, soil type and season in which it is spread

Differences in growth patterns (i.e. the fact that grass grows earlier in the season than clover) mean that careful consideration must be given to nutrient applications. Heavy applications of N early in the season have detrimental effects.

Small strategic applications (up to 50 kg/N/ha) can encourage grass growth without detrimentally affecting clover growth.

How to apply

Avoid smothering grass and clover because this can lead to lower intakes and the potential growth of undesirable bacteria, such as clostridia, entering the silage clamp at second cut. It is also important to minimise disturbance to clover stolons – particularly during the first 18 months after establishment.

Injector systems apply slurry evenly without contaminating field margins and pose minimal risk of surface run-off. Injectors also help to break up areas of soil compaction, while eliminating damage to soils and worm populations that can be caused when slurry puddles at the surface. Slurries with less than 6% DM should be injected into the soil to make the most of the available N. Injection may be less suitable earlier in the season, both from an economical point of view and because coulters cut through the clover stolon network, which leads to setback. Repeated use may have damaging effects.

Deep injection machinery can handle larger volumes of slurry, but are often restricted to certain soil types.

Band spreaders apply slurry in strips on the surface. They are only effective when used on short swards and may make the slurry vulnerable to losses. Trailing shoe machines operate with taller sward covers; slurry is distributed underneath the sward to prevent ammonia loss. Both the trailing shoe and band spreader can be used on any soil type, but, like the shallow injector, are limited to applications below around 35 m^3/ha (3,200 gal/acre).

Reduced ammonia emissions following land spreading

Source: Misselbrook et al., 2002

Potential health problems

Bloat

Bloat is a build-up of gas (carbon dioxide and methane) inside the animal, caused by the rapid breakdown of clover protein. Pressure exerted on the diaphragm, heart and lungs by the distended rumen causes distress and sometimes death.

Effective management can minimise or eliminate the risk of bloat in livestock grazing clover-dense swards.

- Limit access when stock are first introduced to the field
- Do not turn hungry stock out onto clover-rich pastures
- Feed fibre, such as hay or straw, before turnout
- Provide fibre (hay/straw) in the field
- Take special care when the day is foggy or damp

There appears to be less risk of bloat when feeding red clover silage, but care must still be taken to provide a balanced ration. Discuss the risk of bloat with a qualified ruminant nutritionist and your vet.

Fertility

Do not feed red clover – fresh or ensiled – to breeding ewes, or diseased white clover for 6 weeks before and after tupping.

Red clover and stressed white clover contain high levels of phytoestrogens, which become more concentrated when ensiled. Phytoestrogens can cause ‘clover disease’ or ‘clover infertility’ in ewes.

Clover disease causes low lambing rates, prolapse, difficult lambing, uterus inflammation and bacterial infection.

Clover infertility, which is caused by permanent damage to the reproductive tract, worsens with exposure to phytoestrogens. The structure of the cervix is damaged and sperm transport is affected, causing reduced conception rates. Clover infertility has no visual signs: ewe cycling and ovaries appear normal. Accurate diagnosis is usually limited to abattoir feedback.

Ewes fed high-estrogen clover may also suffer from temporary infertility, which can be reversed within a month of changing the diet. Vulva and mammary gland swelling will be visible in some breeds.

There have been no reports of negative effects on the fertility of male stock.

Effects are less severe in white clover, but high phytoestrogens can cause reduced ovulation and delayed oestrus.

It is less common for breeding cows to graze red clover, but experiments have shown that silage made from this crop does not affect herd fertility.

Pests and diseases

Table 7. Pests and diseases of clover

Disease/pest	White clover	Red clover
Stem eelworm	Causes distortion of growing buds and young leaves and death of the plant Note: Not the same strains for white and red clover, so white clover can be sown between red clover crops to break the pest cycle	Most important pest Most effective control is rotation – a 5-year break is recommended between red clover crops, extended to 7 years if stem eelworm is present
Slugs	Major pests for both red and white clover Use molluscicide*	
Sitona weevil	More common in arable areas – leads to removal of small, semi-circular sections of leaf Treatments for frit fly or leatherjackets can reduce the pest problem, but no specific insecticide is available	Not applicable
Leatherjackets	More common after ploughing old pastures Sprays for leatherjacket control are no longer available Consider killing off the grass in the autumn and leaving the land fallow over the winter, before reseeding in the spring. Improve soil drainage Potential biocide use, e.g. *Bacillus thuringiensis*, but no clear scientific support as yet	Not applicable
Powdery mildew	Not applicable	Visible in small patches of fine, white-grey, cobweb-like growth on upper leaf surface, which develops into a white dusting Apply fungicide* at first sign of disease, unless late in season, when application will not be cost-effective Use resistant varieties

Table 7. Pests and diseases of clover (continued)

Disease/pest	White clover	Red clover
Viral diseases	*Clover yellow vein virus* (CYVV) – severe strains can cause intense, severe yellowing of leaves, followed by premature death. Plants are usually stunted and seed pods show some deformation	*Red clover vein mosaic virus* (RCVMV) – causes plants to be stunted, with yellowing, curling leaves. Plants rapidly wilt and collapse Several aphid species, including the pea aphid, can transmit the virus There are no known, resistant, commercial cultivars
Pepper spot	Small, blackish-brown lesions of about 1 mm in diameter are produced in great abundance; the whole leaf looks like it has been sprinkled with black pepper. The surrounding areas gradually turn yellow and eventually the leaf withers	Not applicable

*Seek advice from a qualified professional and ensure sprayer operators are fully qualified.

Recovery

White clover will often rapidly recolonise areas affected by pests or diseases by extending the stolons of the remaining plants into the gaps.

Red clover plants grow from a single crown, so recolonisation of areas affected by pests or diseases is not possible. Grow with companion grasses to help prevent weed ingress into bare patches.

Sclerotinia damage – plants rarely recover

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