Chapter 4

# Silage from pastures and forage crops

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## In this chapter



## The authors


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**Key Issues ... see Page 2**

## Section 4.0
# Introduction

The pastures and forage crops discussed here are the major sources of parent material likely to be conserved as silage.

As producers develop greater interest and experience with silage, they are likely to use a wider range of crops, e.g. forage brassicas and chicory. Unfortunately, there is very little experimental data or experience in ensiling these less commonly grown crops. In the absence of clear guidelines, assume that non-'grass' crops may have a high buffering capacity and low WSC content, and may be difficult to ensile (see Chapter 2, Section 2.1.4). They should be treated as for legumes – wilting is essential (see Chapter 4, Table 4.1; Chapter 5, Table 5.2; and Chapter 6, Table 6.3).

The crops discussed are those grown specifically for grazing, for forage production or both. Silage cutting is often integrated with grazing to improve the utilisation of surplus growth.

Silage is produced in a wide variety of climates in Australia, so specific management strategies have not been included. Local information is needed on varieties, fertilisers, irrigation management, and weed and pest management.

Seedbeds left uneven or cloddy after sowing may need rolling, before plant emergence, to prevent soil contamination of the forage at harvest. As well as creating wear problems with equipment, soil contamination can also introduce undesirable bacteria, which may affect silage fermentation (see Chapter 8, Section 8.7).

**Plate 4.1**

*Well-managed tropical grasses have the potential to produce a large bulk of medium-quality silage. This panic pasture should have been cut several days earlier; its quality is declining quickly as it runs to head.*

*Photograph: M. Martin*

## The Key Issues

- The most cost-effective production of silage is when there is a genuine excess of forage that cannot be grazed.
- The silage's nutritive value varies with the species and variety conserved, and the growth stage at which it is cut.
- Attention to good agronomic management is essential to achieve high forage yields of high nutritive value.
- Both feed quality and quantity are important in determining the profitability of animal production from silage. Silage quality places a limit on the potential animal production per tonne of silage DM. Production of low-quality silage is likely to be unprofitable.
- Monitor soil fertility using soil tests and ensure long-term soil fertility is maintained by replacing nutrients removed in silage.
- Read all labels on pesticides and chemicals used on silage parent forage to ensure they are used correctly and stock withholding periods are satisfied.

Section 4.1

# A comparison of pastures and forage crops suitable for silage production

Silage is often only made from pastures or forage crops when growth is surplus to the animals' requirements. A feed budgeting approach can be used to estimate the quantity of surplus forage likely to be available for conservation (see Chapter 1).

The cost of growing these pasture and forage crops should only be considered in a budget for silage when inputs have been increased specifically for silage production, e.g. higher fertiliser rates or increased irrigations. There are also potential pasture management and weed control benefits that can be attributed to silage which should be taken into account (see Chapters 3 and 11).

Table 4.1 summarises characteristics of pastures and forage crops commonly grown for silage production, emphasising the forage management strategies required to optimise silage quality. There is a huge range in the quality of silages being produced (see Chapter 12, Appendix 12.A1). The large range suggests many producers are losing production potential because of poor silage-making practices.

**Table 4.1**

*Production potential, management requirements and suitability of pasture and forage crops for silage production.*

| Crop | Perennial ryegrass & clover | Forage ryegrass | Other temperate perennial grasses & clover | Pasture legumes & legume dominant pastures[1] | Lucerne | Kikuyu & other tropical grasses | Forage sorghum | Millet (several types) | Cowpea & lablab |
|---|---|---|---|---|---|---|---|---|---|
| Growth stage at harvest | 1st head emerge on ryegrass | 10-20% head emergence | Stem elongation of grass component | Early to mid flowering | Very early (<10% flower) | 25-35 days growth | 1 m high | Pennisetums: 1 m high Japanese: pre-boot | Flowering |
| Potential yield[2] (t DM/ha/cut) | 2.5-4 | 2.5-4.5 | 2-4 | 2-3.5[1] | 1.5-3.2 | 2-3.5 | 2-5 | 2-5 | 1.5-6 |
| Potential number of cuts per year[2] | 1–2 | 1–2 | 1 | 1–2 | 4-7 | 1-3 | 1-4 | 1-3 | 1 |
| Wilting requirement | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Target range DM content (%) | | | | | | | | | |
| Chopped | 30-40 | 30-40 | 30-40 | 35-40 | 35-40 | 35-40 | 30-40 | 30-40 | 35-40 |
| Baled | 35-50 | 35-50 | 35-50 | 35-50 | 35-50 | 35-50 | 35-50 | 35-50 | 35-50[6] |
| ME[3] (MJ/kg DM) | 9.5-11 | 9.5-11 | 9.5-10.5 | 9.5-11.5 | 9-10.5 | 8.5-10 | 9-9.5 | 9-10 | 8.5-10.5 |
| Crude protein[3] (% DM) | 12-22 | 12-20 | 12-16 | 14-26 | 18-24 | 12-18 | 7-17 | 10-18 | 14-18 |
| Ensilability[4] | ** | ** | ** | * | * | * | ** | ** | * |
| Suitable for chopped bulk silage | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Suitable for baled silage | Yes | Yes | Yes | Yes | Yes | Yes | Yes[5] | Yes[5] | Yes[6] |

*Notes:*

1. *High-density legumes have potential to produce higher yields (3.5-7.0 t/ha) than pasture legumes sown at the usual rates. Management requirements for silage production and potential forage quality are as for pasture legumes.*
2. *Yields and potential number of cuts are for crops cut at the optimum growth stage. Yields at the higher end of the range can be obtained with irrigated crops or crops grown under ideal growing conditions.*
3. *The ME (metabolisable energy – see Glossary for definition) and crude protein values shown are in the range that is achievable with good management.*
4. *Ensilability: likelihood of achieving a good silage fermentation without wilting or additives. (* Low ** Medium *** High)*
5. *Baling is not recommended for tall, rank crops unless the baler is fitted with knives.*
6. *Although cowpeas and lablab may be made into baled silage, it is not the preferred option (see Section 4.12.3).*

Section 4.2

# Factors affecting the yield and feed quality of silage

The principles discussed in this section apply to most of the crops and pastures used as silage parent forage. Later sections in this chapter and in Chapter 5 contain more specific information relevant to the crops and pastures most likely to be used for silage production.

## 4.2.1

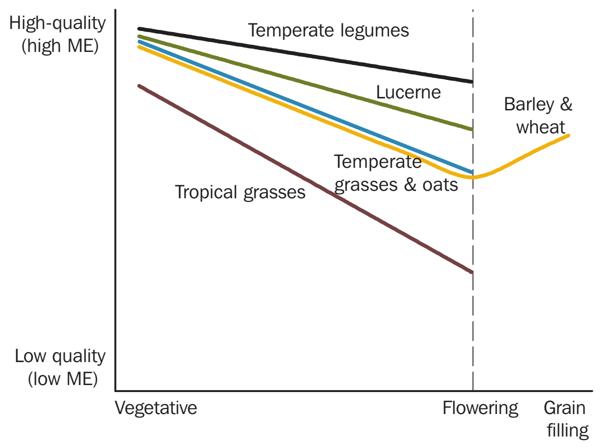
## *Crop or pasture type*

The quality of the parent forage sets an upper limit on the quality of silage or hay that can be conserved. Young temperate grasses and legumes, such as clover and lucerne, have high forage quality (good digestibility, ME and protein levels) and have the potential to be conserved as high-quality hay or silage.

Mature temperate grasses and rank summer grasses or crops have low forage quality and can never be made into good quality silage or hay. Figure 4.1 shows the relative ranking of crops and pastures in terms of expected quality.

**Figure 4.1**

*Forage quality (ME content) of the parent forage decreases as the plants mature.*




## 4.2.2

## *Soil fertility*

Soil fertility can influence potential yield, pasture growth rates and capacity for regrowth, as well as forage quality. For example, a grass pasture or crop that is nitrogen deficient will have lower protein and ME levels. Deficiencies in other nutrients that affect yield, such as sulphur, also often affect forage quality.

High soil fertility and good crop growth can sometimes contribute to lower forage quality if a crop is harvested late. For example, a very vigorous forage sorghum crop can quickly become tall and rank if harvest is delayed.

### Nutrient removal and fertiliser application

Large amounts of nutrients are removed when high-yielding crops and pastures are conserved as hay or silage (see Table 4.2). For example, a kikuyu pasture yielding 4 t/ha removes 96 kg N/ha, 12 kg P/ha, 100 kg K/ha and 10 kg S/ha. Nutrients removed must be replaced if long-term production is to be sustained.

Fertiliser requirements vary with soil type and will depend on soil test analyses and nutrient removal levels. Local advice should be sought for fertiliser application rates.

Fertiliser should be applied before the start of the pasture or crop's main growing season to avoid loss of production. This is usually in autumn for the temperate species. If high rates are required, split applications, e.g. in autumn and spring, will reduce the risk of nutrient loss. A spring application will improve recovery after harvest.

Large amounts of potassium are removed when forage is harvested, but local advice should be sought before applying high rates of potassium fertiliser. Excessive levels of potassium in forage may lead to an increased incidence of grass tetany in lactating cattle.

Nitrogen fertiliser can be a valuable tool in improving carrying capacity over the whole farm. It can improve recovery after grazing and increase DM yields from shorter closure periods. If soil moisture is adequate, additional nitrogen applications during periods of active plant growth can produce a greater bulk of forage and increase the amount available for conservation.

While nitrogen application can improve production of the grass component of grass/legume pastures, a more vigorous grass component can suppress the legume portion if it is not managed correctly.

The impact of nitrogen fertiliser on perennial ryegrass is discussed in Section 4.3.2. Many of the principles covered in that section apply to other grass-dominant pastures, although more investigation is required to determine economic responses for many of the pasture species.

## Effluent disposal

Silage production can be a useful tool in reducing the build-up of nutrients on land treated with effluent from dairies, piggeries and feedlots.

Effluent should not be applied to crops and pastures within six weeks of the forage being harvested for silage. Late application can result in physical contamination of the forage with undesirable bacteria, which may adversely affect silage fermentation and animal health.

To avoid contamination, the effluent should either be spread on bare ground before sowing, on very short crops and pastures early in the growing season or immediately after a silage cut. Effluent containing large particles should not be used if there is a risk these will be picked up by the harvesting equipment.

If effluent is to be used on early-cut cereal crops or grass-dominant pastures, producers should be aware that high nitrogen rates could affect the ensilability of forage (see Section 4.3.2 and Chapter 2, Section 2.1.2). Wilting guidelines must be followed to ensure a successful fermentation (see Table 4.1).

**Table 4.2**

*Approximate nutrient removal rates (kg/t DM) when forage is harvested.*

| | Nitrogen (N) | Phosphorus (P) | Potassium (K) | Sulphur (S) | Calcium (Ca) | Magnesium (Mg) |
|---|---|---|---|---|---|---|
| Perennial temperate grass/clover mixes | 35* | 3.0 | 20 | 2.5 | 8.0 | 2.4 |
| Pasture legumes (clover, medic) | 35* | 3.0 | 25 | 2.5 | 13 | 3.0 |
| Lucerne | 35* | 3.0 | 25 | 3.0 | 15 | 4.0 |
| Kikuyu | 24 | 3.0 | 25 | 2.5 | 2.7 | 3.0 |
| Hybrid forage sorghum | 24 | 3.0 | 20 | 2.0 | 3.0 | 3.0 |
| Millet | 25 | 3.0 | 20 | 2.5 | 3.0 | 3.0 |
| Cowpeas, lablab and summer legume crops | 28* | 2.5 | 25 | 3.0 | 10 | 2.5 |

** Nitrogen requirement met by legume nitrogen fixation.*

*Data derived from various computer databases*

## 4.2.3

### Weeds, pests and diseases

The quality and yield of the parent forage may decline with infestations of weeds, pests and diseases. Some weeds, such as thistles and barley grass, may contaminate wool, damage animals' mouths (causing ulcers) and affect feed intake (see Chapter 3, Section 3.3). Other weeds are poisonous, can taint milk or can be unpalatable. Some weeds, e.g. capeweed, are difficult to make into silage (see Chapter 2, Section 2.1.4).

The valuable role of silage production in weed management in pastures is discussed in Chapter 3, Section 3.3.

Select and prepare paddocks for forage conservation well in advance of harvest. Select paddocks free of problem weeds, pests and diseases or control these before they impact on yield and quality. Care should be taken when using any chemicals (see Section 4.2.6 for more detail).

Pastures will recover more quickly if cutting height is >5 cm.

**Plate 4.2**

*Poor-quality pasture will not produce high-quality silage.*

*Photograph: A. Bowcher*

## 4.2.4

### Growth stage at harvest

Digestibility, ME content and protein levels of plants are highest when the plants are in the early vegetative growth stage. As grasses mature, they become more fibrous and their forage quality declines rapidly. The forage quality of legumes tends to decline more slowly. Cereals, such as wheat and oats, are of highest digestibility and protein content when young and leafy. As they mature, energy becomes concentrated in the grain, stems become more fibrous and less digestible, and some leaves die off. In some cereals, the increase in grain content can offset the quality loss due to increasing fibre content in the stem (see Figure 4.1 and Chapter 5, Table 5.2).

The best growth stage for harvest is often a compromise between quality and quantity. The recommendations for specific pastures and crops are summarised in Table 4.1 and Chapter 5, Table 5.2. Greater detail for these 'parent forages' can be found in the relevant sections of Chapters 4 and 5.

Mature crops provide a larger bulk of lower quality forage than young, vegetative crops. Late-cut crops are usually unsuitable for enterprises with high production targets such as milk or meat production. Returns from animal production on late-cut silages may not cover the cost of conservation. The matching of silage quality to animal production targets is very important and is covered in Chapters 13, 14 and 15.

4.2.5

## Dry matter content and wilting

The dry matter (DM) content of a conserved forage often affects how well it is preserved. The importance of DM levels is discussed in detail in Chapters 2 and 6. The recommended DM range for ensiling pastures and crops are given in Table 4.1 and Table 5.2. It is important that the forage DM levels are within the specified range when storing. The key issues are:

- If the DM content of silage is too low (<30%), there is a risk of a poor fermentation, reduced silage quality and increased effluent losses.
- If the DM content is high (>50%), forage losses increase and silage can be difficult to compact, with a risk of poor fermentation, mould growth and overheating.
- The time taken to wilt a crop to the desired DM level is critical. During wilting, respiration continues, reducing the forage quality. If wilting continues for more than 48 hours, forage quality can drop significantly. A slow wilt allows growth of aerobic bacteria, yeasts and moulds, which further increases losses of DM and quality.

Management strategies to accelerate the rate of wilting are discussed in Chapter 6, and the use of additives to reduce spoilage or improve fermentation is discussed in Chapter 7.

4.2.6

## Caution – pesticides

When using pesticides or other chemicals on crops and pastures intended for hay or silage:

- always read the label – failure to follow label guidelines is illegal; and
- always observe the withholding period.

The labels on most chemicals include a withholding period (WHP). This is the specified minimum time between chemical treatment and the commencement of a production process, such as harvesting or grazing, and relates to the label dose rates only. An Export Slaughter Interval (ESI) is the recommended withholding period for livestock and produce destined for export and is often longer than the WHP for the same chemical. Updated WHP and ESI information is available from Meat and Livestock Australia (MLA) and on the MLA website, <www.mla.com.au>.

Our trading partners do not use some of the chemicals registered in Australia. *Any* detectable level of these in animal products may exclude those products from that market.

Many chemicals do not break down during the ensiling process; observe the WHP for grazing and cut *after* that date for silage. Produce from livestock eating forage within the designated WHP is not acceptable for human consumption.

The restrictions applying to chemical use on crops and pastures can change. This is the case with endosulfan. Recent restrictions stipulate that no feed straw, fodder, trash or by-product that has had any foliar treatment of endosulfan can be fed to livestock.

A signed Vendor Declaration form, requested on purchase of forage, should stipulate chemical treatments used on the crop or pasture.

Avoid chemical residues in silage:

- Time chemical applications to ensure that WHPs and ESIs are satisfied.
- Attend to chemical records, particularly if the intended use for the crop or pasture changes. This is more likely to be important if a crop intended for grain harvest is cut for hay or silage instead. Chemicals may have been used on the crop that could compromise silage use.
- Minimise use of chemicals on crop or pasture to be ensiled.
- Do not grow forage where spray drift from nearby crops is possible. For example, forage crops could be put at risk if crops requiring high chemical usage are grown in an adjacent paddock.
- Keep up-to-date with the acceptable WHPs and ESIs for chemicals used in forage production programs. Review them regularly.

Section 4.3

# Perennial ryegrass and clover

Perennial ryegrass/clover pastures are ideally suited to grazing, with the excess in spring best managed by forage conservation.

4.3.1

## *Variety selection*

Perennial ryegrass varieties are selected for their production and persistence under grazing. Variety maturity will affect the optimum harvest date (see Table 4.3).

Late-maturing varieties can be closed up later in the growing season and still produce an acceptable yield at the optimum growth stage (early head emergence). Early-maturing varieties must be harvested sooner to produce high-quality silage. They may be more suited to areas with shorter or less reliable spring growing seasons.

Some perennial ryegrass varieties tend to be short and fine and may be difficult to harvest for silage. Erect varieties may be more suitable for silage production.

### Endophyte in perennial ryegrass silage

Perennial ryegrass pastures may contain the fungal endophyte *Neotyphodium lolii*. The endophyte assists perennial ryegrass establishment and growth by protecting against a range of insect pests. However, toxins produced by this fungus can affect animal health, causing staggers, susceptibility to heat stress and reduced production.

There is evidence that the endophyte toxins will persist in silage and affect milk yield.

The level of endophyte will vary depending on perennial ryegrass variety and paddock management. The toxic effect is usually low in early spring and increases with rising temperatures and reproductive development, to a maximum at seed head emergence. Toxicity then falls in post-reproductive regrowth only to increase again in summer due to moisture stress and perhaps increasing temperature.

High nitrogen application can increase the level of toxin.

**Table 4.3**

*Perennial ryegrass quality after three weeks regrowth, sampled in December (South Coast, NSW).*

| Variety | Maturity | DM digestibility (%) | ME (MJ/kg DM) | Crude protein (% DM) |
|---|---|---|---|---|
| Javelin | Very late | 66.8 | 10.0 | 22.0 |
| Super Nui | Mid-season | 63.7 | 9.6 | 16.1 |
| Ellett | Mid-season | 63.3 | 9.5 | 20.2 |
| Concord | Mid-season | 61.1 | 9.2 | 18.6 |
| Grassland Nui | Mid-season | 60.1 | 9.0 | 17.2 |
| Kangaroo Valley | Very early | 58.8 | 8.8 | 17.7 |

*Source: Adapted from Kemp (1994)*

4.3.2

## Management for silage production

- Replace nutrients removed – based on soil test results and the information in Table 4.2.
- Depending on soil test results, potassium fertiliser may be required in clover-dominant pastures.
- Where high rates of N, P or K fertilisers are required, split applications can minimise nutrient losses.
- Topdress with 50-70 kg N/ha if ryegrass dominates.
- Irrigate as required, if irrigation is available.
- Graze heavily, mulch, slash or mow back to 5 cm stubble before closure. Remove as much dead material as possible to avoid a reduction in forage digestibilty and contamination of the ensiled material with undesirable micro-organisms.

**Table 4.4**

*A comparison of yield and ME content of perennial ryegrass six weeks after nitrogen application, harvested at the early ear emergence growth stage (western Victoria).*

| Nitrogen applied (kg N/ha) | Yield (t DM/ha) | ME (MJ/kg DM) |
|---|---|---|
| 0 | 1.6 | 11.2 |
| 25 | 1.9 | 11.4 |
| 50 | 2.2 | 11.2 |
| 75 | 2.3 | 11.3 |
| 100 | 2.3 | 11.4 |

*Source: Adapted from Jacobs (2000)*

### Nitrogen fertiliser applications

Pastures with adequate fertiliser inputs recover more rapidly after grazing or harvest. If not limited by moisture or other nutrients, nitrogen application to a nitrogen-deficient pasture produces a quick growth response. The pasture can be harvested sooner, at a less mature stage of growth, producing higher yields and higher quality silage.

However, with high nitrogen rates the decline in forage quality will be more rapid and timely harvest is critical. High nitrogen levels can cause plants to mature more quickly, with a greater risk of lodging.

Increases in growth rate and yield of >30% have been recorded from pastures in most regions of Australia. Growth responses have varied from 12 to 26 kg DM/kg N. Table 4.4 provides an example of pasture response to a range of nitrogen rates.

If soil moisture and other nutrients are not limiting, nitrogen application rates of 50 to 70 kg N/ha should increase yields and maintain, or improve, digestibility, ME and crude protein levels. Higher nitrogen rates may further increase yield (kg DM/ha), but DM production per kg of nitrogen applied, and therefore economic return, is likely to be less and the risk of environmental pollution is increased.

Nitrogen topdressing may reduce DM content of plants and reduce the concentration of plant sugars (water soluble carbohydrates – WSCs). Because successful silage fermentation depends on adequate WSC levels, it is important that topdressed ryegrass pasture is wilted to recommended DM levels (see Table 4.1) to concentrate WSCs and allow a good fermentation (see Chapter 2).

Low WSC levels are more likely if the pasture is harvested less than four weeks after nitrogen topdressing.

4.3.3

## Growth stage at harvest

The optimum growth stage to harvest a perennial ryegrass pasture for silage is when the first seed heads start to appear. A compromise has to be made between forage quality and DM yield. DM yield will be highest when seed heads are fully developed. However, forage quality is dropping quickly at this stage and will only support low animal growth rates or milk production.

A short closure of four weeks in spring will ensure high-quality silage. A longer closure, while increasing DM yields, may lower feed quality (see Table 4.5). Forage quality will usually decline by 0.25-0.6 MJ/kg DM per week of delay in silage harvest. In most regions, perennial ryegrass silage should be harvested before mid-November.

### Closure dates and lengths of closure

Optimum dates and period of closure will vary with location, seasonal conditions, varietal maturity, stocking rate and availability of surplus pasture.

When to close a pasture for silage is best judged by the growth stage of ryegrass and the amount of residue remaining in a paddock after grazing (see Chapter 3). If ryegrass has 3½ or more leaves before grazing and/or a residue of >1.5 t/ha DM remains after grazing, the pasture is being under-utilised and the surplus may be closed for conservation.

Early closure is more likely with well-fertilised pastures, low stocking rates, early-maturing varieties or in northern NSW and Queensland. An early harvest allows more regrowth and a quick return to grazing or a second silage harvest. There is also potential for higher total forage production (see Chapter 3, Section 3.1.1). A later closure time often requires a shorter closure period due to faster plant growth rates and rapid maturing of the pasture, but total DM production is likely to be less.

It is worth considering staggering closure dates to spread workload and risk of weather damage at harvest.

**Plate 4.3**

*A clover/ryegrass pasture can produce high-quality silage.*

*Photograph: N. Griffiths*

### Legumes in perennial ryegrass pasture

Legumes in the pasture have potential to increase digestibility and crude protein levels of silage. However, WSC levels of the ryegrass/clover mix will be lower, making a quick, effective wilt more important. Clover-dominated pasture mixes should be harvested at the clover's mid-flowering growth stage.

**Table 4.5**

*Effect of growth stage on potential yield and quality of perennial ryegrass pasture. Forage quality will vary with proportion of legume.*

| Growth stage | ME (MJ/kg DM) | Crude protein (% DM) | Potential yield (t DM/ha) |
|---|---|---|---|
| Vegetative (25 cm) | 10.0-11.0 | 15-25 | 1.5-3.0 |
| Head emergence (40 cm) | 9.5-11.0 | 12-22 | 2.5-4.0 |
| Flowering | 8.5-10.0 | 10-20 | 2.5-5.0 |

Section 4.4

# Other temperate perennial grass/legume mixtures

Phalaris, cocksfoot and tall fescue are important temperate grass species, usually sown with clovers (and sometimes lucerne). Grown specifically for grazing, they have potential to produce high-quality silage. They are grown for their persistence and adaptation to a wider range of soil types and growing conditions than perennial ryegrass (see Table 4.6).

A vigorous stand of these perennial grasses can dominate the pasture's legume component if not managed correctly. Silage production is a valuable management tool in helping maintain a strong legume component. Producers should aim for a pasture with at least 20% legume (see Chapter 3).

**Table 4.6**

*Minimum annual rainfall requirement of temperate grass species.*

| Grass species | Minimum rainfall requirement (mm/year) Winter Dominant Zone | Minimum rainfall requirement (mm/year) Summer Dominant Zone |
|---|---|---|
| Cocksfoot | 450 | 750 |
| Tall fescue* | 450 | 650 |
| Phalaris | 525 | 700 |
| Perennial ryegrass* | 700 | 800 |

* *In drier areas these species will perform better at high altitudes.*

*Source: McDonald (2001)*

## 4.4.1

### *Species and variety selection*

Selecting the most suitable species, variety and combination of grasses and legumes depends on climate and other growing conditions. Obtain local advice for species and variety recommendations.

The choice of which variety and species to grow is usually governed by the livestock enterprises on the farm, rather than the potential of the pasture for conservation. However, particularly in areas of poor summer rainfall, high-quality temperate pasture silage is having an increasingly important role, enabling producers to achieve demanding production targets. In these situations producers need to rethink their species choice to ensure the combination of pasture species grown can produce silage cuts in most seasons.

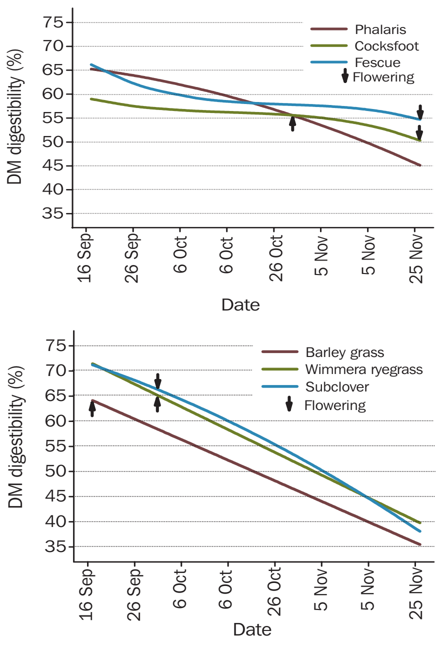
Where climate and soil conditions allow, a range of mixtures may be grown on the one farm. This will help increase pasture utilisation and aid management by extending the spring growing season. An example of this could be a mixture of the later-maturing perennial ryegrass/ subclover/white clover on the more fertile, sheltered areas, with phalaris/cocksfoot/ subclover the main mixture on the balance of the farm.

Such a combination takes advantage of the spread of maturity of the species and extends the potential production period in the event of late spring/summer rainfall. If a large amount of silage is to be cut, having a range of pastures with varying maturities extends the harvest window.

Although the flowering dates shown in Figure 4.2 do not apply in all areas, the graph does indicate the differences in maturity and digestibility levels that occur between temperate pasture species. The data also highlight the effect of maturity on digestibility level. Note that these data are from 1968 research and do not reflect the diversity of maturity now available with the wide range of current varieties. The digestibility values in this study are low, which may be a consequence of seasonal conditions.

**Figure 4.2**

*DM digestibility and flowering date of temperate species at Northfield, South Australia.*




*Adapted from Radcliffe and Cochrane (1970)*

## 4.4.2

## *Management for silage production*

- Select pastures with good legume content.
- Ensure good pasture nutrition, replacing the nutrients removed (see Table 4.2) to sustain long-term productivity.
- Topdressing with nitrogen will increase DM production and forage quality if the grass component is dominant and the pasture has a poor legume history.
- Minimise insect damage and control problem weeds.
- During winter, in the lead-up to closure, strategically graze the pasture to prevent rank growth of the grasses and to encourage the legume component.

The temperate perennial grass/legume pastures can be returned to grazing management after silage is cut. However, be aware that the early harvest time required to produce high-quality silage

**Plate 4.4**

*The phalaris pasture in the background has not been grazed and has become rank. Livestock will selectively graze the highly digestible, fresh growth in the foreground, which has been grazed to maintain the pasture in the vegetative growth stage.*

*Photograph: M. Keys*

from these pastures affects the ability of the grasses to replenish root energy reserves. Heavy grazing pressure on the regrowth could severely affect the density of the grass component, particularly under poor growing conditions, such as low soil moisture or poor nutrition.

Pastures should not be cut for hay or silage during the year of establishment. Forage production from the same paddock in successive years is also not advisable if the density of the perennial grass component is low.

## 4.4.3

### *Growth stage at harvest*

The forage quality of temperate grasses falls quickly after flowering (see Figure 4.3). The optimum time to cut is a trade-off between quality and yield – at about the commencement of stem elongation for the grass component of the pasture mixture. Note that this is earlier than the ear emergence growth stage recommended for perennial ryegrass.

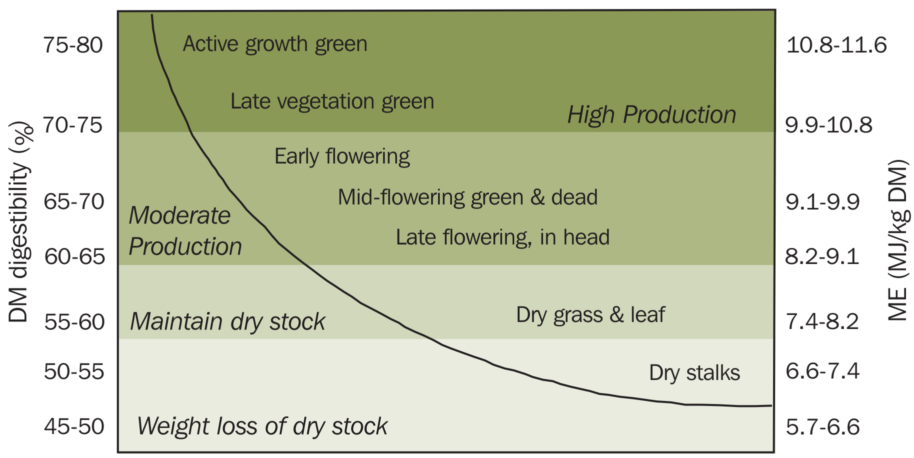
A pasture with a high legume component has a wider harvest window than a grass-dominant pasture. The higher proportion of legume slows the decline in forage quality when harvest is delayed.

A similar situation occurs in long-season areas where mild growing conditions encourage late tiller development of the pasture's grass component. The decline in quality of the grass component will be slower than in short-season areas where the harvest window is quite narrow.

Both these situations may apply if microclimates exist on the one farm. Areas of more fertile soil or those protected from harsh weather conditions will often have a prolonged production period.

**Figure 4.3**

*As temperate grasses mature, forage DM digestibility and ME levels decline.*




*Source: Adapted from Bell (2000)*

## Closure dates and period of closure

The wide range of locations, seasonal conditions, growing conditions, pasture types and grazing pressures affecting the temperate grass/legume mixtures used for silage production in Australia makes pinpointing optimum dates or periods of closure difficult. Often the closure date coincides with when there is adequate pasture growth to support the grazing stock on the balance of the farm.

In the lower altitude zones, warmer spring growing conditions will produce good growth rates, with pastures reaching yield targets and the preferred growth stage for cutting about 6-7 weeks after closure.

Slower plant growth and the use of later-maturing varieties in the higher altitude zones requires a longer period of closure – about 8-10 weeks.

The earlier-maturing pastures, e.g. phalaris-based pastures, must be closed early enough to allow adequate growth before the onset of maturity. However, by closing a pasture too early there is a risk of the grass component reaching the preferred cutting stage too early in the season, when the risk of poor wilting conditions is greater.

A range of pasture mixtures of different maturities allows for a spread of closure and harvest dates.

Section 4.5

# Forage ryegrass

Forage ryegrasses include annual, biannual, Italian, short rotation, *westerwolds* and *multiflorum* types. These ryegrasses are commonly sown as an annual forage crop, but may grow for two years. They usually have better seedling vigour and are more productive than perennial ryegrass in the year of establishment. Winter and early spring DM production is also usually greater than that of perennial ryegrasses.

The self-regenerating, annual Wimmera ryegrass forms an important component of subclover pastures in the temperate and Mediterranean zones of southern Australia. The management and cutting strategies to produce high-quality silage from these pastures are similar to those for forage ryegrasses. Silage production can reduce seed reserves of annual ryegrass and affect regeneration the following season (see Chapter 3, Section 3.2).

Ryegrass can be made into hay or silage. Hay making is governed by weather conditions, usually late in the season when the weather is warm and the ryegrass is mature. This hay is usually of poor quality. Silage, on the other hand, is made earlier, when the quality of the pasture is higher.

When surplus pasture is available, it is best to make silage from forage ryegrass and graze perennial ryegrass stands.

Forage ryegrasses do not contain the ryegrass endophyte that may be a concern with perennial ryegrasses (see Section 4.3.1).

## 4.5.1

### *Variety selection*

Forage ryegrasses have a wide range of maturities, varying from early seeding varieties such as annual ryegrass, which may have seed heads emerging in September, through to very late seeding varieties, which may still be vegetative in December.

New varieties regularly become available as seed producers strive for high yields and better disease tolerance. Contact your local adviser for preferred varieties in your area.

Ryegrasses usually contain high levels of WSC, with forage ryegrasses higher than perennial ryegrass and tetraploid varieties higher than diploids. Tetraploid forage ryegrasses usually have higher WSC levels than other types of pasture and can be expected to have the most effective silage fermentation, provided adequate wilting is achieved.

While the maturity rating of varieties varies, the optimum growth stage to harvest for silage is consistently at the early head emergence growth stage (10-20% seed heads visible). Regions with irrigation or a long spring growing season can grow varieties with a range of maturities to spread their silage harvest season.

4.5.2

## Management for silage production

- Fertilise as required ensuring good pasture nutritition; replace nutrients removed in forage harvested (see Table 4.2).
- Topdress with 50-70 kg N/ha to ensure rapid growth (see Section 4.3.2).
- Graze heavily, mulch, slash or mow back to a 5 cm stubble if required. Remove any heavy mulch to allow rapid, even regrowth and to avoid contamination of silage with dead or decaying material.
- Irrigate as required, if available.

4.5.3

## Growth stage at harvest

The effect of growth stage on forage quality and yield is demonstrated in Table 4.7. The yield/quality compromise for forage ryegrasses is at 10-20% head emergence, shown in Plate 4.5.

**Plate 4.5**

*The optimum growth stage to harvest ryegrass for silage is at early seed head emergence and is a compromise between yield and quality.*

*Photograph: N. Griffiths*

**Table 4.7**

*The effect of growth stage on quality and yield of forage ryegrass.*

| Growth stage | ME (MJ/kg DM) | Crude protein (% DM) | Potential yield (t DM/ha) |
|---|---|---|---|
| Vegetative (30 cm) | 9.7-11.0 | 14.0-22.0 | 2.0-3.0 |
| Boot or head emergence (45 cm) | 9.0-10.5 | 12.0-20.0 | 2.5-4.5 |
| Flowering | 8.0-9.0 | 8.5-18.0 | 2.5-5.5 |
| Mature seed | 6.0-8.0 | 3.5-7.5 | 2.2-5.0 |

Section 4.6

# Pasture legumes (clover, medics and high-density legumes) and mixed annual legume/grass pastures

Clover-dominant pastures are grown to produce very high-quality forage that can be grazed or conserved as hay or silage. Clovers are usually grown in a mixture with various grasses, although they may be grown as a pure sward. This applies particularly to the annual forage clovers such as Persian, berseem or arrowleaf, also known as high-density legume crops (HDLs) when sown at high seeding rates.

Clover silage is potentially of high quality, however, it requires a rapid and effective wilt. Despite their high forage quality, clovers tend to have low WSC content. They must be wilted to concentrate WSC to allow successful silage fermentation (see Chapter 2, Section 2.1.2).

Good-quality silage is usually easier to make when the pasture contains a mixture of clover and grasses. However, with good management excellent silages can be made from pure legume crops and pastures.

> There is no clear evidence of pure legume silage causing bloat. Although producers have reported that animals seem 'full', with distended rumens, this appears to be a result of high silage intake rather than gas production in the rumen.

**Plate 4.6**

*Red clover.*

*Photograph: N. Griffiths*

## 4.6.1 *Species and variety selection*

These comments provide a brief overview of characteristics of several species of clover. The late-maturing species are better suited to silage production than the early-maturing species. They have a longer growing season and reach the preferred growth stage for cutting later in the season when wilting conditions are more favourable. The late-maturing species are also likely to produce more regrowth after cutting. Obtain local advice for species recommendations.

### White clover

White clover is a perennial, winter-active species. Survival over summer depends on water availability and temperatures. A surplus for silage is most likely to be available in late spring.

White clover is almost always sown in a pasture mixture. It can become dominant in some situations, for example, in spring when sown over a kikuyu pasture and on the northern Tablelands of NSW when good moisture conditions promote growth in spring.

All white clover varieties have high feed value. Erect, large-leaved types will develop a larger bulk and are more suitable for harvest as silage or hay than small-leafed, prostrate-growing varieties.

### Red clover

Red clover is a short-lived perennial with more active summer growth than most white clover varieties. Red clover may be sown in a pasture mixture or as a pure stand. It is sometimes used as a short-term alternative to lucerne. Red clover is more erect and can produce a larger bulk of DM for harvest than white clover.

## Persian clover

Persian clover (previously referred to as Shaftal clover) is an annual forage type clover, producing very high-quality forage. Persian clover will tolerate wet conditions and some waterlogging.

There are two subspecies of Persian clover. The major subspecies is late maturing with thick hollow stems and very low levels of hard seed. Varieties include Maral, Leeton, Laser and Lightning. These types tend to have an erect growth habit and high yield potential, suitable for silage production. They require a mower-conditioner to crush stems and increase the drying rate.

The other subspecies are earlier maturing, more prostrate in growth and are not as well suited to silage production. Varieties include Kyambro, Nitro and Prolific. They have high hard seed levels.

Persian clovers have been successfully grown alone or with forage ryegrass or oats.

## Berseem clover

Berseem clover is a late-maturing annual forage clover with tolerance to wet conditions and some waterlogging. It has soft seed and is usually planted each year. Berseem is an alternative to the erect types of Persian clover in areas with a long spring growing season.

## Subterranean clover

Subclover, the most widely grown annual clover in southern Australia, will tolerate moderate levels of soil acidity. The available varieties have a wide range of maturities and growth characteristics. Silage is more likely to be made from high-yielding, late-maturing varieties grown in regions with a long spring growing season. A silage harvest in the establishment year is likely to significantly affect stand density in subsequent years.

**Plate 4.7**


*Berseem clover.*

*Photograph: N. Griffiths*

Subclover is often grown in mixes with perennial or annual temperate grasses (see Sections 4.4 and 4.5). Potential DM yield is boosted by including a grass component with subclover.

## Balansa clover

Balansa is an annual clover usually grown in pasture mixes. It is early maturing with very high, hard seed levels and good tolerance to disease and waterlogging. Balansa has a prostrate growth habit during winter followed by a period of rapid erect growth when flowering in spring. This rapid growth can produce a large bulk of forage suitable for conservation as silage or hay.

There is little potential for regrowth and seed set after harvest, even if balansa is harvested early in spring. Regeneration will depend on hard seed reserves from previous years. A silage harvest in the establishment year will limit seed production and is not recommended if the aim is for regeneration the following year.

**Plate 4.8**

*Balansa clover.*

*Photograph: N. Griffiths*

## Arrowleaf clover

Arrowleaf clover is a late-maturing annual clover suited to well-drained soils. It is deep rooting and performs best in sandy or gravelly soils with neutral to acid pH. Arrowleaf clover can regenerate from hard seed. It can produce a bulk of spring growth suitable for storage as hay or silage. Thick stems can make drying difficult and require conditioning.

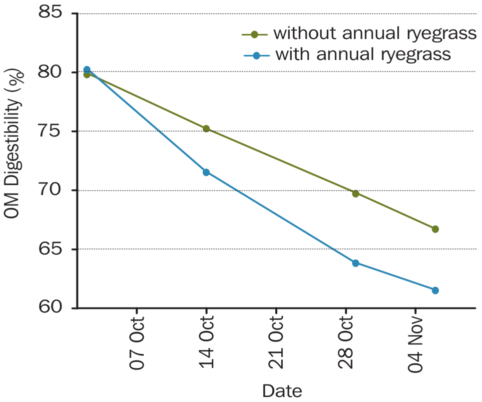
## Crimson clover

Crimson is a soft seeded annual clover suited to a wide range of soil types, similar to subclover. It will tolerate some waterlogging but prefers well-drained soils.

Although not widely grown in Australia, crimson clover is an erect species, reputed to be well suited to silage making.

**Figure 4.4**

*The effect of annual ryegrass content on organic matter digestibility changes in an HDL crop – arrowleaf, berseem and Persian clover, sown with and without Wimmera ryegrass (Wagga Wagga, NSW).*




*Source: Kaiser et al. (unpublished data)*

## High-density legumes (HDLs)

HDL is a mix of annual clovers, sown at high sowing rates, to provide a one or, potentially, two-year break crop in a cropping rotation. The term was first used to describe pure legume pastures, such as white clover, sown at high sowing rates in the dairying regions of Queensland and northern NSW.

Species commonly used in a mix are Persian, berseem, arrowleaf or balansa clovers. A total of 10-20 kg/ha of seed is desirable to maximise DM production. Because HDLs are often used as a break crop, cultivar selection is usually based on soft seed levels to prevent regrowth in the following crop. Cultivar selection will also depend on soil pH and drainage.

HDLs are used for grazing, silage, hay or green manuring. There may be potential for grazing prior to harvest if they are sown early and there is enough moisture for adequate growth. The high nitrogen input from HDLs, even after cutting for silage or hay, contributes to higher yields in the following cereal crop(s). Cutting HDLs for silage also provides a viable management option for herbicide-resistant weed problems in cropping rotations, provided cutting takes place before weeds set seed and there is no seed set from weed regrowth.

Figure 4.4 highlights the advantage of including legumes in grass/legume pasture mixes destined for forage production, as a means of improving quality and delaying the decline in quality as the pasture matures.

## 4.6.2

### *Management for silage production*

- Most species benefit from early sowing to allow good growth before winter.
- Ensure adequate fertiliser rates at sowing; replace nutrients removed in silage (see Table 4.2).
- Control problem insects and weeds.
- Irrigate as required, if available.

## 4.6.3

### *Growth stage at harvest*

The best time to harvest clover pastures for silage is at the early to mid-flowering growth stage. White and subclover can be harvested at mid or late flowering and retain very high forage quality.

Some of the forage types of clover such as red, berseem, arrowleaf, balansa and crimson will develop a higher proportion of stem and associated lower feed value if they are cut too late. With these species, cutting at the bud or an early flowering growth stage is preferred so as to maximise forage quality (see Table 4.8).

**Table 4.8**

*Yield (t DM/ha), organic matter digestibility and crude protein of legume forage crops harvested at three stages of crop growth (Wagga Wagga, NSW).*

| Species* | 2 October harvest | | | 23 October harvest | | | 6 November harvest | | |
|---|---|---|---|---|---|---|---|---|---|
| | Yield (t/ha) | OMD (%) | Crude protein (% DM) | Yield (t/ha) | OMD (%) | Crude protein (% DM) | Yield (t/ha) | OMD (%) | Crude protein (% DM) |
| Karridale subclover | 4.8 | 76 | 19.8 | 6.2 | 72 | 13.3 | 6.6 | 69 | 11.8 |
| Balansa | 5.7 | 83 | 16.7 | 6.6 | 72 | 13.6 | 6.2 | 65 | 10.8 |
| Arrowleaf | 4.7 | 79 | 20.6 | 7.5 | 73 | 15.2 | 7.3 | 66 | 12.4 |
| Berseem | 3.9 | 77 | 18.3 | 7.5 | 69 | 13.1 | 5.4 | 65 | 14.1 |
| Murex medic | 4.9 | 77 | 21.9 | 8.8 | 70 | 13.8 | 7.8 | 55 | 12.4 |
| Barrel medic | 3.7 | 78 | 20.0 | 3.7 | 71 | 15.5 | 3.8 | 50 | 12.7 |
| Tetraploid ryegrass** | 7.0 | 74 | 6.1 | 10.0 | 62 | 4.9 | 9.2 | 50.5 | 3.7 |

** All species were sown at high sowing rates.*

*** Tetraploid ryegrass – var. Richmond*

*Source: Adapted from Dear et al. (unpublished data)*

Section 4.7

# Lucerne

Sodium supplements may improve animal production when the diet contains a significant proportion of lucerne silage.

Lucerne is the traditional, preferred summer-growing hay crop. However, lucerne silage is becoming more popular, particularly in cooler months and wet seasons when high losses are likely from attempts to make hay.

Lucerne silage is a high-quality forage. Silage has the advantage over hay of lower field losses, resulting in potentially higher digestibility and crude protein levels. Silage is removed from the paddock one or two days sooner after cutting than hay, allowing earlier irrigation and return to production.

## 4.7.1

### *Variety selection*

There are numerous lucerne varieties available commercially, with varying growth patterns, disease resistance, insect tolerance and tolerance to a range of soil types, growing conditions and management regimes. Selection will depend on the variety best suited to the environmental and management pressures of each individual situation. Local advisers should be consulted for specific recommendations.

**Plate 4.9**

*Lucerne can be cut for hay or silage when the first flowers are visible to optimise forage quality. Harvesting lucerne before flowering will increase forage quality but may shorten stand life.* *Photograph: N. Griffiths*

## 4.7.2

### *Management for silage production*

- Lime application is recommended, before sowing, if soil tests indicate soil acidity.
- Ensure good plant nutrition; replace nutrients removed in silage (see Table 4.2). Use split applications where high rates of fertiliser are needed.
- Control all weeds for pure lucerne silage, although some growers will use an early silage cut as a method of weed control. If the lucerne is harvested when the grass weeds are in boot or early heading growth stage they may assist silage fermentation.
- Control insect pests. Ensure that any insecticides being used are registered for use on crops to be cut for hay or silage and that withholding periods are satisfied before harvesting. A silage harvest may provide effective insect control, for example, late infestations of aphids or lucerne leaf roller.
- Beware of the potential to spread diseases when moving machinery to new paddocks.
- Lucerne may be oversown with forage ryegrasses or oats for silage production.
- Irrigate as required, if available.

**Table 4.9** *The effect of growth stage on forage quality and yield of lucerne.*

| Growth stage (plant height) | ME (MJ/kg DM) | Crude protein (% DM) | Potential yield (t DM/ha) |
|---|---|---|---|
| Vegetative (30 cm) | 10.0-11.0 | 22-28 | 0.75-1.4 |
| Late vegetative – budding (45 cm) | 9.0-10.0 | 18-24 | 1.2-2.4 |
| Early flowering (50 cm) | 8.0-9.5 | 15-22 | 1.5-3.2 |
| Late flowering (60 cm) | 6.0-8.0 | 6-15 | 1.8-4.0 |

## 4.7.3

## *Growth stage at harvest*

Lucerne is best harvested for silage between full bud and commencement of flowering. In highly winter-active varieties, new growth from the crown is also an indicator that the crop is ready to cut.

An irrigated lucerne trial at Kyabram, Victoria, (see Figure 4.5) demonstrated that cutting at early flowering is a compromise, with yield continuing to increase and quality declining as lucerne matures.

The decline in forage quality with crop maturity applies equally to irrigated and dryland lucerne stands. Table 4.9 shows the range in yield, ME level and crude protein content, which can be expected over a range of growing conditions.

### Cutting height

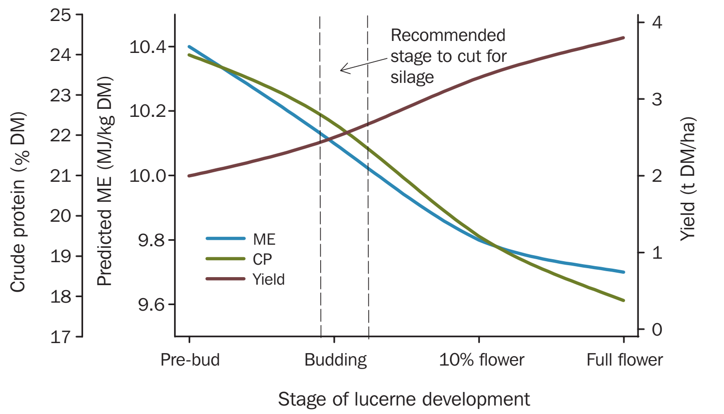
Cutting height for lucerne is usually set at 3-5 cm. Raising the cutting height will reduce yield and increase forage quality by increasing the ratio of leaf to stem. A taller stubble may improve regrowth but can contaminate the next harvest if cutting returns to a lower height. Cutting too low will damage the high crown of highly winter-active varieties, leading to disease infection and reduced stand life.

### Cutting frequency and persistence

Although cutting early will improve quality of lucerne forage, frequent early cutting affects yield potential and stand persistence. The adverse effect of frequent, early cutting on stand persistence was demonstrated in the Kyabram study (see Table 4.10). As is the case with most perennial pasture species, the ability of a lucerne plant to recover after grazing or cutting, and to persist, depends on the level of carbohydrate reserves in the roots. If the plant is not allowed to progress to flowering at some stage of the growing season, root reserves will decline and long-term production and persistence is jeopardised.

**Figure 4.5**

*The effect of growth stage on yield, ME content and crude protein level of lucerne harvested at Kyabram, Victoria.*




*Source: Adapted from Slarke and Mason (1987)*

**Table 4.10** *The effect of cutting frequency on yield and persistence of lucerne stands after two years of harvesting at Kyabram, Victoria.*

| Growth stage | Total yield per season (t DM/ha) | Cuts/ season* | Relative plant frequency (%) |
|---|---|---|---|
| Pre-bud emergence | 13.5 | 6.8 | 41 |
| Budding | 15.0 | 5.9 | 57 |
| 10% flowering | 16.4 | 5.0 | 71 |
| Full flower | 16.3 | 4.3 | 73 |

* *The number of cuts averaged over two seasons.*

*Source: Adapted from Slarke and Mason (1987)*

Section 4.8

# Kikuyu grass

Kikuyu is the tropical grass most frequently conserved as silage in Australia. Managed correctly, it can produce large quantities of medium-quality silage (9-10 MJ/kg DM). Kikuyu has a relatively high crude protein level compared to other tropical grasses. Its low WSC content means wilting is essential to concentrate WSCs and improve fermentation (see Chapter 2, Section 2.1.2).

Harvesting kikuyu for silage has become a popular management tool to control excess growth (see Chapter 3). An autumn silage cut is an excellent preparation for over-sowing kikuyu pasture with ryegrass or clover.

Because kikuyu silage is usually only medium quality, it must be conserved cheaply to have a useful place in farm management. Nitrogen fertiliser, harvesting and baling are the main costs in making kikuyu silage.

**Plate 4.10**

*For the best-quality kikuyu silage, graze hard then slash or mulch and remove old growth before fertilising for rapid, medium-quality regrowth.*

*Photograph: N. Griffiths*

4.8.1

## *Management for silage production*

- ➤ Ensure good plant nutrition to maintain vigorous pasture; replace the nutrients removed in silage (see Table 4.2).
- ➤ Topdress with 50-70 kg N/ha after closure to improve yield. Higher rates may produce economic responses if moisture is not limiting.
- ➤ Graze heavily, mulch, slash mow or forage harvest back to a 5 cm stubble, leaving the pasture free of trash for a quick, even regrowth. It is critical to remove any trash or rank growth that is likely to contaminate the silage and affect digestibility and the silage fermentation.

Over-sowing with white clover will improve the quality of forage from a kikuyu-based pasture. Kikuyu/white clover mixes need to be managed carefully, with cutting or strategic grazing, to prevent the kikuyu from becoming too dominant.

Depending on soil nutrient status, phosphorus, sulphur and/or potassium may be required to improve production from companion clover or over-sown winter grasses.

## 4.8.2

## *Growth stage at harvest*

The best quality kikuyu silage is made from young, leafy growth, approximately 25-30 cm high, 25-35 days after closure (see Figure 4.6). A 20-day closure period is possible under ideal growing conditions.

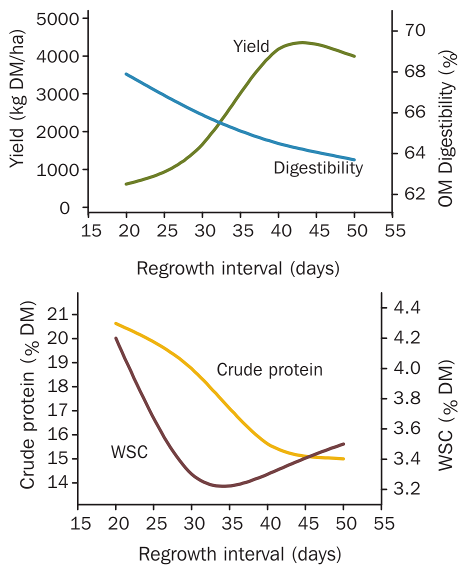
Delaying harvest past the recommended 25-35 day regrowth period results in a decline in energy and protein levels (see Table 4.11). Experience on the south coast of NSW indicates that organic matter digestibility falls at a rate of about 2.5 percentage units per week.

When kikuyu (or other tropical grasses) becomes rank, quality is low and its fibrous nature makes it difficult to compact in the silo.

### Wilting requirement

Kikuyu's WSC content is well below the desired level of 2.5-3.0% in the fresh forage (see Chapter 2, Section 2.1.2). Therefore, a rapid wilt is recommended for successful preservation of the kikuyu forage. Aim for 35-40% DM for chopped bulk silage, or 35-50% DM for baled silage. The importance of wilting rate in silage production is covered in Chapter 6. If a rapid wilt is not possible, a silage additive, such as molasses, may be required (see Chapter 7, Section 7.4).

**Figure 4.6**




*The effect of regrowth interval on yield, organic matter digestibility, WSC content and crude protein level of kikuyu harvested at Berry, NSW.*

*Source: Kaiser et al. (2000a)*

Sodium supplements may improve animal production when the diet contains a significant proportion of kikuyu silage.

**Table 4.11**

*The effect of growth stage of kikuyu on silage quality and potential yield.*

| Growth stage | ME (MJ/kg DM) | Crude protein (%) | Potential yield (t DM/ha) |
|---|---|---|---|
| Vegetative (25-35 days growth) | 9-10 | 15-20 | 2.0-3.5 |
| Late vegetative (40-50 days growth) | 8-9 | 11-15 | 2.5-5.0 |
| Rank (>50 days growth) | 6-8 | 6-10 | 3.0-8.0 |

Section 4.9

# Other tropical grasses

Tropical grasses such as setaria, paspalum, Rhodes grass, panic (Guinea grass) and pangola grass may be conserved as silage. However, good management is required to ensure the quality of the silage produced is good enough to make the exercise profitable.

Most tropical grasses can produce a large bulk of forage during their growing season. However, this bulk quickly becomes fibrous, with a low leaf:stem ratio and low nutritive value. Forage conservation is often difficult because the surplus growth is usually available in the wet season when it is difficult to predict the few fine days needed to cut and wilt the grass.

**Plate 4.11**

*As with most tropical grasses, the quality of Rhodes grass falls rapidly as growth becomes rank and plants run up to head.* *Photograph: M. Martin*

Currently, many producers opt to leave surplus pasture growth as dry standing feed, allowing stock to select the best diet they can from a large bulk of poor quality material. However, converting the excess feed into silage at a vegetative growth stage, before quality deteriorates, could improve livestock production.

A conservation strategy involving silage may also have a role in pasture management (see Chapter 3). Regular cutting of higher-quality forage, in conjunction with increased grazing pressure on other areas of the property, would prolong higher quality vegetative growth stage of the pasture.

A study at Lawes, in south-east Queensland, showed the potential value of this approach for several tropical grass species (see Table 4.12). When the grasses were cut at 28-day intervals, from October to March, the ME was maintained at a relatively high level (9 MJ/kg DM). When the grasses were left uncut and ungrazed, the ME values declined to very low levels over a 98-day period – from October to February.

When rapid pasture growth rate exceeds demand, it may be more beneficial to leave areas ungrazed and uncut to concentrate on maintaining maximum quality on a smaller area of the farm.

**Table 4.12**

*The effect of cutting interval on estimated ME levels (MJ/kg DM) of five tropical grass species grown at Lawes, south-east Queensland.*

| Regrowth intervals | Setaria | Paspalum | Rhodes grass | Guinea grass | Pangola grass |
|---|---|---|---|---|---|
| 28 days (average October to March) | 9.2 | 8.5 | 8.9 | 8.8 | 9.0 |
| 28 days (from October close) | 9.5 | 8.3 | 8.8 | 9.2 | 9.7 |
| 70 days (from October close) | 7.9 | 7.2 | 8.1 | 7.3 | 8.2 |
| 98 days (from October close) | 7.3 | 6.2 | 7.0 | 6.9 | 6.9 |

*Source: Adapted from Minson (1972)*

4.9.1

## Management for silage production

There is a lot of debate about the profitability of silage production from tropical pastures. However, by concentrating on leafy forage, with a short regrowth interval, it should be possible to produce medium-quality silage with an ME content of 9-9.5 MJ/kg DM (see Table 4.12).

Additional economic benefits are likely through the strategic use of silage cutting as a pasture management tool (see Chapter 3). Silage cutting can be a worthwhile management strategy on improved tropical grass pastures, as has been proven with kikuyu.

- Fertilise to promote growth. Seek local advice.
- Prepare pasture by heavy grazing or mulching to remove rank, low-quality growth. It is essential to identify pastures earmarked for conservation early so they can be managed to avoid contamination of the silage with decaying grass.
- Perennial grass/legume mixtures may not be more digestible than early-cut grass, but crude protein levels are likely to be higher, which should result in an increased animal intake and production. The pasture's legume component is likely to decline with repeated silage harvests, although reports from the Northern Territory indicate Wynn cassia has thickened and become dominant after harvesting a mixed pangola grass pasture for silage for two or three years.
- After harvesting silage, return the pasture to the normal grazing rotation, unless another silage harvest is planned from the same area.

4.9.2

## Growth stage at harvest

The major problem with silage production from tropical grasses is that they are often cut too late. It is worth sacrificing significant yield to produce silage of higher digestibility. It is preferable to cut forage before stem elongation commences, well before seed heads emerge. Less than 4 weeks growth is preferred for most pasture types.

The quality penalties suffered with late cutting of kikuyu (see Section 4.8.2), apply to tropical grasses in general. Table 4.13 shows the reduction in forage quality that can be expected if harvest is delayed.

The low WSC levels in tropical grasses makes wilting essential. However, it is important to avoid excessive wilting (see Chapter 2 and Section 4.8.2).

Tropical grasses are more fibrous than many temperate grass species, making silage compaction in a pit or a bale more difficult. Fine chopping or the use of a baler with chopping/cutting capacity can improve compaction.

**Table 4.13**

*The effect of growth stage on ME and crude protein levels of three tropical grass species.*

| Species | Growth stage | ME (MJ/kg DM) | Crude protein (% DM) |
|---|---|---|---|
| Rhodes grass | Early vegetative | 8.7 | 16.0 |
| | Late vegetative | 7.2 | 12.0 |
| | Flowering/stemmy | 6.5 | 9.0 |
| Setaria | Early vegetative | 8.7 | 16.0 |
| | Late vegetative | 6.5 | 10.0 |
| | Flowering/stemmy | 6.0 | 8.0 |
| Paspalum | Early vegetative | 8.5 | 17.0 |
| | Late vegetative | 7.8 | 12.0 |
| | Flowering/stemmy | 7.0 | 9.0 |

*Source: Estimates from Camdairy®, Hulme et al. (1986)*

### Ammoniated forage

Ammonia is sometimes used to increase digestibility and preserve low-quality roughage, such as cereal straw (see Chapter 5, Section 5.3.4). This technique may also be effective with tropical grasses that have become rank.

Mature tropical grasses should be wilted to 55-75% DM before applying anhydrous ammonia or urea. (Urea must be mixed evenly at a rate of 40-50 kg/tonne of DM.) The forage is then packed and sealed to exclude air and prevent ammonia loss. The urea is hydrolysed to produce ammonia, which then reacts with moisture to form ammonium hydroxide. Unlike silages, ammoniated forages do not ferment and have a final pH of 9 to 10 (compared to a pH of about 4 for silages).

Ammoniation of tropical grasses requires further research and development to determine if, and where, it can be safely and profitably used in Australian agriculture. It must be noted that ammoniation of mature tropical grasses would only ever be a salvage exercise. The forage produced has only medium digestibility. Storing vegetative grass as silage is the preferred option.

Section 4.10

# Hybrid forage sorghum

Fine-stemmed forage sorghums and Sudan grass hybrids are preferred for baled hay or silage, although most varieties can be used for chopped silage. Forage quality is usually only medium, but deteriorates rapidly if growth is not controlled and the crop is allowed become rank.

Although growing forage sorghums specifically for silage is an option when a large bulk of medium-quality silage is required, sweet sorghum is often preferred for silage production (see Chapter 5, Section 5.6). Surplus growth from forage sorghum crops grown for grazing may be ensiled in favourable seasons.

Sorghums have been grown with legumes, such as lablab, in an attempt to increase protein levels. The reduction in sorghum sowing rate required to enable the legume component to be competitive produces significantly lower yields. The yield penalty and management difficulties encountered when growing a blend of forage species makes the sourcing of an alternative protein component for the diet the preferred option.

Plant breeders have been able to improve the forage quality of forage sorghums using the brown midrib (*bmr*) gene. The *bmr* gene may reduce yields, but this disadvantage is usually outweighed by an increase in forage quality. The first commercially available *bmr* sorghum x Sudan grass hybrid was released in Australia in 2001.

Prussic acid poisoning can be a risk to animals grazing moisture-stressed sorghum crops in the vegetative growth stage. It is not likely to be a concern with forage sorghum silage, which is usually made in good growing seasons, when there is a forage surplus. Furthermore, up to 50% of the prussic acid is lost in the ensiling process (see Chapter 5, Section 5.5).

**Hybrid forage sorghums and forage pennisetums**

| Forage type | Cultivars available | Uses |
|---|---|---|
| **'Forage sorghum'** | | |
| Sudan grass (*S. sudanese*) | Open pollinated and hybrid | Dual purpose – multiple grazings and/or conservation (hay and silage) cuts. |
| Sorghum × Sudan grass (*S. bicolor x S. sudanese*) | Hybrid | Dual purpose – multiple grazings and/or silage cuts. |
| Sweet sorghum* (*S. bicolor*) | Open pollinated and hybrid | Generally single direct cut for silage, or grazed as a standover crop. Grain content varies. |
| Multiple purpose sorghum* (*S. bicolor*) | Hybrid | Often used for silage. Grain content generally high; low grain forage types are no longer widely grown. Can produce two cuts in northern Australia or can be used for various combinations of grazing, silage and grain. Similar to but often with a shorter growth habit than American 'forage sorghum'. |
| **Grain sorghum*** | | |
| Conventional grain types (*S. bicolor*) | Hybrid | Shorter growing types selected for grain production but sometimes used for silage. |
| **Forage pennisetum** | | |
| (*Pennisetum spp.* but mostly *P. americanum*) | Open pollinated and hybrid | Dual purpose – multiple grazings and/or silage cuts. |

** Chapter 5 covers the suitability of these crops for silage production.*

*Source: Kaiser and Piltz (2002)*

Inclusion of sulphur and sodium supplements in rations containing sorghum silage may improve animal production.

## 4.10.1

### *Management for silage production*

- Good establishment requires soil temperatures at sowing depth to be above 16°C and rising, at 9:00 am.
- Ensure good plant nutrition; replace nutrients removed in silage (see Table 4.2).
- Graze or cut to ensure even regrowth.
- Topdress with nitrogen before closing for silage. Apply 50-100 kg N/ha per cut, for rapid recovery.
- Irrigate as required, if available.
- After cutting for silage, forage sorghum can be returned to grazing management or closed for another silage cut.

## 4.10.2

### *Growth stage at harvest*

Harvesting when the crop is about 1 m high is a compromise between quality and quantity. Forage quality often drops quickly when forage sorghums exceed 1.2 m high or seed heads emerge.

Table 4.14 shows the effect of crop height and growth stage on potential yield and expected forage quality of forage sorghums. Table 4.16 gives the results of a trial comparing yield and quality of forage sorghum and millets.

Raising the cutting height can improve the quality of the forage harvested. However, disposal of the residue may create problems if a winter crop is to follow.

**Plate 4.12**

*Brown midrib sorghum (a leaf is shown on the left) has the potential to produce higher quality silage than conventional forage sorghums.*

*Photograph: K. Kerr*

**Table 4.14**

*The effect of forage sorghum growth stage on silage quality and potential yield.*

| Growth stage | ME (MJ/kg DM) | Crude protein (% DM) | Potential yield (t DM/ha) |
|---|---|---|---|
| Vegetative (60 cm) | 9.5-10.0 | 12-18 | 1.0-2.5+ |
| Vegetative (100 cm) | 9.0-9.5 | 7-17 | 2.0-5.0+ |
| Vegetative or heading (>200 cm) | 7.0-8.0 | 4-11 | 6.0-12.0+ |

Section 4.11

# Millet and forage pennisetum

Many millets can be grown for forage, with the option to graze or cut and conserve any surplus. These include Japanese (*Echinochloa esculenta* cv. Shirohie), white pennisetum or Siberian (*Echinochloa frumentacae*) and forage pennisetum (formerly referred to as pearl millet).

Millets are usually cheaper to grow than forage sorghums and should produce higher-quality forage, although they do not have the yield potential of the forage sorghums. Seek local advice regarding the best performing millets for your area.

**Plate 4.13**

*To produce high-quality forage from forage pennisetums (pearl millet) they should be cut before seed heads emerge.* *Photograph: N. Griffiths*

4.11.1

## *Management for silage production*

- Sowing requirements depend on variety; seek local advice.
- Japanese and Siberian millets tolerate waterlogging; forage pennisetums do not.
- Japanese millet can be planted early in spring, when morning soil temperature at 10 cm is at least 14ºC.
- Siberian millet and forage pennisetums (pearl millet) need warmer conditions for best growth. They should not be planted until morning soil temperatures are at least 18ºC.
- Fertilise as required; replace nutrients removed in silage (see Table 4.2).
- Depending on variety, millets should be grazed early to encourage tillering. Early-maturing varieties will thin out severely if grazed late, and the crop is tall.
- If grazing, topdress with nitrogen fertiliser at 50-100 kg N/ha at closure.
- If not grazing, ensure that adequate nitrogen is applied at sowing or by topdressing after establishment.
- To maximise regrowth potential and total forage yield Japanese millet must be kept in a vegetative growth stage.
- If regrowth is required from forage pennisetums, leave high stubble when cutting (15-20 cm). Other management requirements for forage pennisetums are similar to those for forage sorghums.
- Being finer stemmed than sorghum, the residue of millet crops is more easily managed when preparing for a winter crop.

**Table 4.15**

*The effect of growth stage of Japanese and forage pennisetums on forage quality and yield.*

| Growth stage | ME (MJ/kg DM) | Crude protein (% DM) | Potential yield (t DM/ha) |
|---|---|---|---|
| **Japanese/Shirohie millet:** | | | |
| Vegetative | 9.0-10.0 | 8.5-18.0 | 1.0-4.0 |
| Heading/flower | 8.0-9.0 | 7.0-15.0 | 2.0-6.0 |
| Milk/dough-grain | 6.0-8.0 | 5.0-11.0 | 2.5-8.0 |
| **Forage pennisetums (pearl millet):** | | | |
| Vegetative | 9.0-10.0 | 10.0-18.0 | 1.0-5.0+ |
| Heading/flower | 7.5-9.0 | 7.5-10.0 | 2.5-10.0+ |

## 4.11.2

### Growth stage at harvest

Because most millets produce low grain yields, harvesting at mature growth stages is likely to produce a bulk of lower-quality forage. Ideally, forage should be harvested before seed heads emerge.

Table 4.15 shows the potential yield and probable ranges in quality of Japanese and forage pennisetums, harvested at various growth stages. Actual values will vary between varieties.

The results from a forage study at WaggaWagga, NSW, (see Table 4.16) highlight the differences between Japanese millet, forage pennisetums and forage sorghums.

No detailed information is available for Siberian millet, although experience in northern NSW and Queensland suggests good 'palatability', high yield potential and good regrowth after grazing.

**Table 4.16**

*Yield and nutritive value of irrigated summer crops harvested at three stages of growth.*

| Crop | Stage of harvest | Days from sowing | Crop height (m) | Yield (t DM/ha) | OM Digestibility (% DM) |
|---|---|---|---|---|---|
| Forage sorghum | Vegetative | 53 | 1.3 | 4.0 | 67.5 |
| (Speedfeed) | Early flower | 66 | 1.7 | 9.4 | 64.8 |
| | Late dough | 89 | 2.0 | 18.0 | 61.6 |
| Japanese millet | Vegetative | 53 | 0.6 | 3.2 | 66.3 |
| (Shirohie) | Early flower | 67 | 1.1 | 6.9 | 66.1 |
| | Late dough | 89 | 1.2 | 10.1 | 62.5 |
| Forage pennisetum | Vegetative | 67 | 1.0 | 6.8 | 69.3 |
| (Supermill) | Early flower | 82 | 1.7 | 10.3 | 65.6 |
| | Late dough | 103 | 1.9 | 17.1 | 64.4 |

*Source: Kaiser (unpublished data)*

Section 4.12

# Cowpeas, lablab and summer legume crops

Summer-growing forage legumes such as cowpea and lablab are useful in rotations as a source of high-quality summer forage. They are best grazed, but can be conserved as silage if surplus forage is available. Grain legumes such as mung bean and adzuki bean can also be conserved as silage but will be lower yielding than the forage crops. These grain crops would only be conserved as silage or hay as a salvage operation if they were not expected to produce a satisfactory grain yield.

Until improved summer or tropical legumes are available, soybeans are the preferred summer legume if a legume crop is to be grown to make silage. Soybeans are discussed in detail in Chapter 5, Section 5.7. Table 4.17 compares the estimated yield and forage quality for cowpea, lablab and soybean crops.

Summer legumes can be made into hay, but they are often very difficult to dry adequately, with high leaf and pod loss a problem. Consequently, silage is a better alternative. Most legume crops have a relatively low WSC level and high buffering capacity, which means they must be wilted to achieve acceptable silage fermentation.

**Plate 4.14**

*Cowpeas.* *Photograph: N. Griffiths*

**Table 4.17**

*Yield and quality comparisons between cowpea (at two growth stages), lablab and soybeans.*

| Growth stage | ME (MJ/kg DM) | Crude protein (% DM) | Potential yield (t DM/ha) |
|---|---|---|---|
| Cowpea – early flower | 9.0-10.5 | 14-18 | 1.5-3.0 |
| Cowpea – pod full | 8.0-9.5 | 9-14 | 3.0-6.0 |
| Lablab | 7.0-10.5 | 12-18 | 3.0-8.0 |
| Soybean | 8.0-9.5 | 15-20 | 4.0-10.0 |

**Table 4.18**

*Forage quality at 70 days after sowing (DAS) and at commencement of flowering for lablab accessions grown at Grafton, NSW, compared to the commercially available varieties Highworth and Rongai.*

| | Lablab accessions Minimum | Lablab accessions Maximum | Lablab accessions Mean | Highworth | Rongai |
|---|---|---|---|---|---|
| Days from sowing to flowering | 40 | 137 | 89 | 114 | 133 |
| **70 DAS:** | | | | | |
| Crude protein (% DM) | 11.6 | 23.4 | 16.7 | 16.5 | 16.9 |
| 70-day DM digestibility (%) | 59.6 | 76.5 | 68.5 | 66.8 | 66.0 |
| 70-day ME (MJ/kg DM) | 8.2 | 10.6 | 9.5 | 9.2 | 9.1 |
| **Flowering growth stage:** | | | | | |
| Crude protein (% DM) | 7.9 | 19.3 | 13.9 | 14.0 | 12.1 |
| DM digestibility (%) | 61.4 | 78.3 | 68.9 | 72.8 | 72.4 |
| ME (MJ/kg DM) | 8.7 | 11.1 | 9.8 | 10.1 | 10.5 |

*Source: Desborough (unpublished data)*

## 4.12.1

### *Species and variety selection*

Although there are only a small number of lablab and cowpea varieties commercially available, trial results indicate the promising potential of some of the recent selections. The results in Table 4.18 demonstrate the quality advantages of some lablab accessions over the currently available varieties.

Table 4.19 shows the yield advantage of later-maturing cowpea varieties, Caloona and Meringa, and the potential of the phytophthora-resistant (PRFC) selections. The quality penalty suffered by delaying harvest until podding is clear from the data. However, the low yields at the earlier growth stage means an early harvest is not likely to be economically feasible.

## 4.12.2

### *Management for silage production*

- Variety selection and sowing time depend on location; seek local advice.
- Fertilise to ensure good plant nutrition.
- Inoculate with the appropriate rhizobia inoculant at sowing.
- Cowpeas or lablab may be grazed and then closed for silage, although a one-off silage harvest should give higher yields.
- These crops do not recover for further grazing after harvest.

**Table 4.19**

*The DM yield, crude protein content and DM digestibility ranges of 10 cowpea selections 50 days after sowing (DAS) and at podding, compared with the commercially available varieties Red Caloona, Banjo, Caloona and Meringa, at Grafton, NSW.*

| Growth stage | Red Caloona | Banjo | Caloona | Meringa | Range for PRFC selections |
|---|---|---|---|---|---|
| **50 DAS:** | | | | | |
| Yield (t DM/ha) | 2.1 | 2.7 | 1.8 | 2.3 | 1.5-2.1 |
| DM digestibility (%) | 76.4 | 80.8 | 75.3 | 74.5 | 76.0-77.1 |
| Crude protein (% DM) | 14.4 | 14.4 | 16.4 | 17.0 | 16.2-18.8 |
| **Podding growth stage:** | | | | | |
| Yield (t DM/ha) | 3.7 | 4.8 | 5.5 | 6.5 | 4.9-6.3 |
| DM digestibility (%) | 68.3 | 73.3 | 64.7 | 65.4 | 66.4-69.7 |
| Crude protein (% DM) | 14.8 | 12.0 | 15.1 | 14.0 | 12.5-13.9 |

*Source: Desborough (unpublished data)*

4.12.3

## Growth stage at harvest

The early flowering growth stage is the preferred time to harvest cowpeas and lablab for high-quality silage production. However, yields are likely to be low. Delaying until the mid-pod-fill stage will increase yield potential, although there is a quality decline as the plants mature (see Table 4.19).

Cowpeas produce moderate levels of DM at podding, the recommended growth stage for harvest, but protein levels at that growth stage are low compared with other forage legumes.

The vines of late-maturing lablab can be very long and tangled, making harvesting difficult. Risk of leaf loss is also a problem in late-harvested cowpea and lablab crops.

Although forage legume crops may be made into baled silage, it is not the preferred option for species or varieties with tough stems. These are difficult to compact and easily puncture the plastic wrap. If baling is the only option, ensiling will be more successful if a baler with a chopping mechanism is used and forage is baled at high density. Chopping the legume forage will improve the rate of sugar release, thereby improving the fermentation process.

Chopping the forage also reduces leaf selection by livestock at feeding.

**Plate 4.15**

*Lablab.* *Photograph: N. Griffiths*