

Silage as a pasture management tool

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The Key Issues

- Silage can be a valuable pasture management tool, allowing farmers to maintain pasture quality and improve utilisation during periods of peak pasture growth. The key objectives are to:
 - use strategic silage cuts to maximise the utilisation of the pasture grown;
 - achieve high total forage production (grazing + silage) during peak pasture growth;
 - maintain high quality in both the silage and grazed pasture. For temperate pastures, a target silage ME of at least 10 MJ/kg DM is appropriate;
 - avoid setting aside paddocks for silage too early if this is likely to create a temporary shortage of pasture available for grazing; and
 - ensure there are no long-term adverse effects of silage cutting on pasture productivity.
- When setting aside paddocks for silage production, farmers have the flexibility to vary the closure date and the duration of closure (or cutting date) and still produce high quality silage.
- A feed budget that compares anticipated pasture growth rate with animal requirements is the best guide for determining when and how much of the grazing area should be set aside for silage. Monitoring post-grazing residues can be the simplest and most practical method in rotationally grazed pasture, as only the pasture surplus to requirements needs to be cut.
- Cutting earlier for silage usually results in a higher-yielding regrowth than after hay cutting. Highest DM production from regrowth is obtained from pastures closed earlier in the season and for a shorter duration.
- Longer-term benefits from strategic silage cutting can include increased content of clover and desirable grasses, and reduced weed content.
- Silage can be used as a weed control strategy. Both timing of the cut and management of the regrowth to prevent seed production are important. If there is significant broadleaf weed contamination or harvesting is delayed for weed control purposes silage quality may suffer. Any trade-off in animal production needs to be weighed against weed control benefits.

Section 3.0

Introduction

Successful grassland farming involves managing the grazing system to obtain a balance between pasture supply and animal demand. In all grazing systems, there are times when available pasture is either more or less than the grazing animals need. Silage can play a key role in transferring pasture from periods of surplus to periods of deficit.

Although traditionally used to fill feed gaps, silage can also be a valuable pasture management tool, allowing farmers to maintain pasture quality and improve utilisation during periods of peak growth.

The use of silage as a pasture management tool is most advanced in the dairy industry, where recent surveys have shown that 30% of dairy farmers nominate this as one of the reasons they make silage. Producers in the other grazing industries are also seeing pasture benefits resulting from early silage cuts. A number of potential pasture benefits have been identified:

- ▶ improved utilisation of the pasture grown (more animal production per hectare);
- ▶ improved perennial legume content and better regeneration of annual legumes;
- ▶ reduced weed content;

- ▶ increased pasture production through better utilisation of surplus growth (pastures maintained at a vegetative stage of growth), particularly from the regrowth following earlier silage cuts;
- ▶ increased regrowth compared to hay; and
- ▶ improved pasture digestibility over the whole farm (removing paddocks for silage production increases the grazing pressure on the rest of the farm, allowing pasture digestibility to remain high for longer).

These benefits have been seen with temperate pastures, but are also likely to apply to tropical grass pastures and to grazed summer forage crops (forage sorghums and millets). However, the legume component of perennial tropical grass/legume pastures may be adversely affected by conservation cuts, leading to reduced legume content (see Chapter 4, Section 4.9.1).

Only a small amount of research (with anecdotal support from farmers and consultants) has been conducted to quantify the benefits, so it is difficult to place an economic value on them. However, they are likely to contribute significantly to the profitability of silage at the whole farm level.

Section 3.1

Integrating silage with grazing management

Maintaining pastures at a high-quality, vegetative stage during periods of rapid growth is a major challenge. There are a number of options to improve the management and utilisation of surplus pasture:

- ▶ Year-round stocking rate can be increased. This will improve pasture utilisation, but could result in a feed shortage during periods of low pasture growth, increasing reliance on imported feed (see Chapter 1, Section 1.5).
- ▶ Buying-in livestock can temporarily increase the stocking rate during the period of peak pasture growth. However, this option is often not practical owing to limited supply of store cattle and high prices when extra stock are needed, and a glut of animals on the market and lower prices when the animals are sold.
- ▶ Requirements for pasture can be altered by changing calving or lambing times. This may be practical in some cases, but will depend on the requirements of the markets being supplied. In any event, this strategy is unlikely to utilise all the surplus pasture over the whole farm, particularly where there is a marked seasonality of pasture production (see Chapter 1, Figure 1.6).
- ▶ Removing a proportion of the grazing area for cropping is an option in some regions.

- ▶ Cut surplus pasture for silage or hay.

Slashing or mechanical pasture topping to remove surplus growth and maintain the pasture in the vegetative growth stage is not included as a management option. Both will maintain pasture quality, but will have little effect on pasture utilisation.

The choice of management options to improve the management and utilisation of surplus pasture growth will vary from farm to farm. The silage option offers considerable potential to increase the productivity of grazing enterprises, but silage cutting needs to be successfully integrated with grazing management.

Plate 3.1

Electric fencing allows portions of pastures or crops to be targeted for intensive grazing, while the balance can be closed for silage production – pasture utilisation increases and the vegetative growth stage of the pasture is prolonged.

Photograph: N. Griffiths



The Key Objectives when integrating silage cutting with grazing management

Key objectives when integrating silage cutting with grazing management are:

1. Maximise the utilisation of the pasture grown by strategically timing silage cuts to remove surplus pasture.
2. Maximise total forage production (grazing and silage) during the period of peak pasture growth.
3. Maximise the quality of both the silage and grazed pasture. The target ME for temperate pasture silage should be at least 10 MJ/kg DM.
4. Avoid closing paddocks for silage too early if this is likely to create a temporary shortage of pasture available for grazing.
5. Ensure there are no long-term adverse effects of silage cutting on pasture productivity.

3.1.1

The importance of timing

Pasture management during the period of peak growth must focus on maintaining pastures at an active vegetative growth stage for as long as possible. Grazing and strategic closure and silage cutting (varying closing and cutting dates) will prolong the supply of high-quality forage.

One of the most important principles in producing high-quality silage is to cut pastures early, when they are at a late vegetative to early reproductive stage of growth. The date of head emergence will vary between cultivars for species such as ryegrass and this must be taken into account when determining closure and harvest dates. The importance of growth stage at harvest is covered in Chapters 4, 13, 14 and 15.

When closing paddocks for silage production, there is flexibility to vary the closure date and the duration of closure. Not all silage paddocks need to be closed or cut at the same time. As pastures start to accumulate surplus, paddocks can be sequentially dropped from the grazing rotation and closed. The date this happens will vary with pasture type and region, and from year to year and farm to farm. Frequent pasture monitoring will indicate when paddocks can be closed for silage.

Early removal of paddocks from the grazing rotation for silage production creates the risk of a temporary shortage of

pasture for grazing. Unexpected weather – a dry spell or cold change – could affect pasture growth rates.

Paddocks closed very early will also be ready to harvest earlier in the silage season, when there is greater risk of poor weather affecting wilting.

Studies have investigated the combined effects of closure date and the duration of closure on the production and quality of both silage and pasture.

The three studies reported here focused on perennial ryegrass-based pastures for dairy production (see Tables 3.1 and 3.2, and Figure 3.1).

In the first study, the pastures were closed and removed from the grazing rotation on either 23 September or 10 October. In each case, the silage was cut four or six weeks later. Pasture and silage production was monitored for each treatment from 23 September to 16 December (see Table 3.1). Digestibility was determined for the forage cut for silage but, unfortunately, not for the uncut pasture.

In the second study, pastures were closed for silage on 16 August, 6 September or 27 September. The closure duration was also varied – the results in Table 3.2 are for closures of 6, 8, 10 and 12 weeks. Pasture and silage production was monitored between 16 August to 13 December. The regrowths were quite poor in this study. Table 3.2 also shows the estimated ME content of the forage cut for silage.

When integrating silage cutting with grazing management producers must take a broad view – they need to optimise the yield and quality of both the silage and the grazed pasture.

Table 3.1

Effect of time and duration of closure for silage on total forage yield over spring and silage digestibility for a perennial ryegrass/white clover pasture at Ellinbank, in Gippsland, Victoria.

Source: Adapted from Rogers (1984) and Rogers & Robinson (1984)

Closure date	Silage closure and cutting dates			
	23 September		10 October	
Duration of closure (weeks). Cutting date in brackets.	4 (21 Oct)	6 (4 Nov)	4 (7 Nov)	6 (21 Nov)
Pasture + silage yield (t DM/ha):				
Pre-closure growth (23 September to 10 October)	–	–	1.8	1.9
Silage (t DM/ha)	2.4	3.4	1.6	2.0
Regrowth to 16 December	4.1	1.9	0.8	0.4
Total yield 23 September to 16 December	6.5	5.3	4.2	4.3
Silage DM digestibility (%)	73.5	71.6	69.2	66.1

Table 3.2

Closure date	Duration of closure (weeks)	Pasture and silage yield (t DM/ha)			
		16 Aug to closure	Silage cut	Regrowth to 13 Dec	Total 16 Aug to 13 Dec
16 August	6	–	1.07	1.53	2.60
	8	–	1.86	1.35	3.21
	10	–	3.14	0.84	3.98
	12	–	3.96	0.44	4.40
6 September	6	0.66	1.29	1.38	3.33
	8	0.72	2.28	0.78	3.78
	10	0.49	3.64	0.35	4.48
	12	0.66	5.60	0.04	6.30
27 September	6	1.13	1.61	0.77	3.51
	8	1.30	2.55	0.25	4.10
	10	1.31	3.72	0.05	5.08
	12	–	–	–	–

Effect of date and duration of closure on pasture and silage yield and estimated silage ME* over spring from perennial ryegrass based pastures in south-western Victoria.

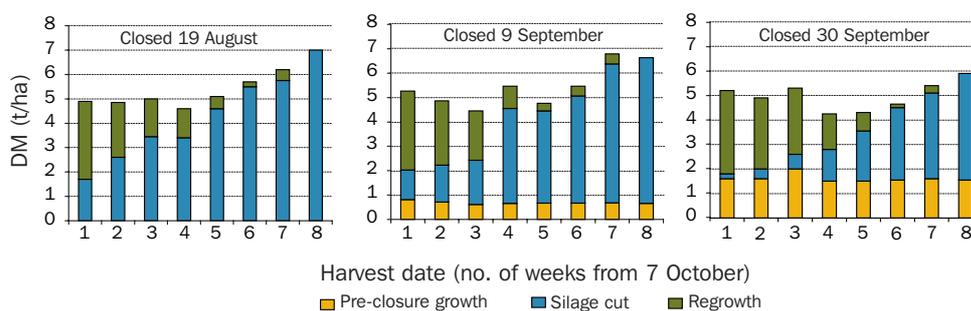
* Estimated ME (MJ/kg DM) content of pasture cut for silage:
 >11.0 10.5–11.0
 10.0–10.5 <10.0

Source: Adapted from Jacobs et al. (1998) – mean results, 2 sites

In the third study, in northern Tasmania, the pastures were closed for silage production on 19 August, 9 September or 30 September. In each case, the first silage cutting treatment was on 14 October, with additional silage cuts at weekly intervals over the next seven weeks. So the duration of the closure was 8-15 weeks, 5-12 weeks and 2-9 weeks for the early, mid and late closure dates respectively. Pasture and silage production was monitored from 19 August to 2 December (see Figure 3.1). Each study showed that both closure date and duration of closure had important effects on silage yield, the combined pasture and silage yield, and silage quality (digestibility or ME). The common principles highlighted in these studies are:

- ▶ The forage quality remains higher, longer for pastures closed early for silage production. This allows the closure period to be extended to achieve higher silage yields, without a quality penalty.
- ▶ In the two Victorian studies, regrowth and combined yield of silage and grazed pasture was higher with earlier closure (see Tables 3.1 and 3.2). This effect of closure date was less important in the Tasmanian study where the growing season is longer. In this case, the early closing was too early, producing no increase in production or forage quality despite an additional 12 days closure compared to the middle (9 September) closure (see Figure 3.2).

Figure 3.1

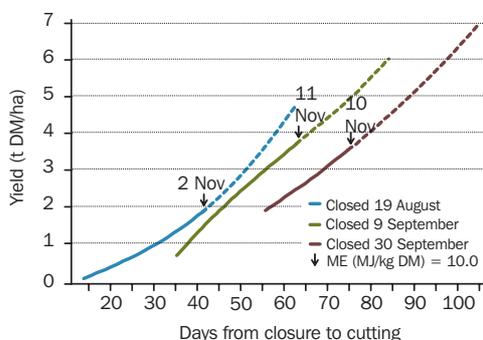


The effects of date and duration of closure on pasture and silage production over spring from a perennial ryegrass/white clover pasture in northern Tasmania.

Source: Belton et al. (1989)

Figure 3.2

Influence of date and duration of closure on the yield and quality of perennial ryegrass/white clover pasture closed for silage in northern Tasmania. Estimated ME falls below 10 MJ/kg DM for closure periods longer than those indicated on each line in the figure.



Source: Adapted from Belton et al. (1989)

- ▶ The grass enters the reproductive stage sooner and quality declines more quickly with later closure. The closure period must be shortened to achieve a satisfactory silage ME and yields will usually be lower (see Figure 3.2).
- ▶ Regrowth yield and the total of the silage and grazed pasture yield can be lower when closure date is delayed, especially if there is an earlier finish to the season.
- ▶ As shown in Figure 3.2, some silage yield often needs to be sacrificed to produce a higher quality silage. This is discussed in greater detail in Chapters 4, 13, 14 and 15.

The application of nitrogen fertiliser is another management tool that provides additional flexibility on grass dominant pastures. Nitrogen not only provides an opportunity to increase silage yield, but also to shorten the closure period (see Chapter 4, Sections 4.2.2 and 4.3.2).

The objective should be to conserve only surplus pasture, in which case there is no

pasture cost debited against silage costs, unless extra inputs, e.g. fertiliser or irrigation, have been used to increase the silage yield. However, there are some cases, for example, in the dairying areas of WA, where a large quantity of high-quality conserved forage is required for feeding during the dry summer/autumn period.

Producers may knowingly restrict grazing of pasture to ensure silage production, and either accept reduced milk production or use supplements. In this case, the cost of lost milk production or bought supplements should be added to silage production costs (see Chapter 11, Section 11.2.6).

The results in Tables 3.1, 3.2 and Figure 3.1 also highlight the flexibility producers have in the selection of closure dates and the duration of closure for silage production. As a pasture surplus accumulates, producers can close more paddocks for silage production. This could lead to a number of cutting dates, spreading the workload over the silage season.

Although this would be an advantage on large farms where large quantities of silage are made, on smaller farms that lack economies of scale, harvesting a number of small batches of silage could increase silage production costs (see Chapter 11). However, with judicious planning it may be possible to synchronise cutting over a number of paddocks, as demonstrated in the example at left.

In this example, using the principles outlined earlier, the producer could aim at producing one batch of silage with a ME greater than 10 MJ/kg DM. The paddocks closed later would need to be closed for a shorter period to achieve this target, and would probably produce a lower yield of silage. A range of pasture types and/or forage crops on the one farm could be used to increase the flexibility of closure time, with less risk of yield and quality penalties.

Example of paddock planning

	Closure date	Duration of closure (weeks)	Cutting date
Paddock 1	20 August	9	22 October
Paddock 2	1 September	7.5	22 October
Paddock 3	10 September	6	22 October

3.1.2

How much pasture and when to close for silage production

The importance of integrating silage into whole farm management was discussed in Chapter 1. Stocking rates need to be increased to improve productivity and profitability on farms where pastures are under-utilised. Silage can facilitate this increase in stocking rate by providing supplementary feed at times of the year when pasture supply or quality is limiting animal production. Silage can also have a role on these farms as a special purpose feed, for example, to finish steers or lambs for premium markets.

Unfortunately, little research has been conducted in the area of timing of silage production and its integration with grazing management, and specific guidelines need to be developed for a range of pastures. In the absence of this information, how do farmers decide how much pasture should be set aside for silage production, and when this should be done?

Set area/educated guess

This is probably the most common method and, at best, will allow some expected feed gap to be filled. It is probably an appropriate strategy on under-stocked farms where only a proportion of the surplus pasture is to be utilised. However, on farms aiming for full utilisation, this is the least accurate method to determine what area needs to be cut for silage. Guessing the appropriate area will almost certainly result in too little or too much being cut. Either of these will cause a reduction in farm profit.

Setting aside too much pasture – an example

If too large an area is cut on a dairy farm and pasture intake of the herd is affected, milk production can suffer. A short-term reduction of 1 kg DM/cow in intake at a time when milk production is particularly sensitive to intake (in spring or peak lactation), could result in a decline in milk production of approximately two litres. At a nominated milk price of 30¢/L, this lost production would add significantly to the cost of the silage. Significant production responses from the silage, either increased stocking rate or production/head would be required to cover this loss.

Post-grazing residue

This method is often used in the dairy industry and while it is considerably better than the set area method, it does have limitations.

Paddocks are removed from the grazing rotation as the grazing residue left behind by the animals increases above a pre-determined target – usually greater than 4–6 cm pasture height or a residue yield of 1,500–1,600 kg DM/ha for perennial ryegrass/white clover pastures for dairy cows. Removal of paddocks from the rotation is stopped when the post-grazing residual returns to the target required for optimum pasture growth and quality. This is about 3–4 cm pasture height or a residue yield of 1,300–1,400 kg DM/ha for perennial ryegrass/white clover pastures. These guidelines will vary marginally between pasture species.

This method is reasonably accurate and easy to put into practice, but its limitation is that it is based on what has already happened (in terms of pasture growth) rather than what will happen. If weather conditions change and pasture growth declines, the result could be too much pasture being set aside for silage. Astute managers can often recognise this problem and return paddocks to the grazing rotation for grazing.

Dung and urine patches

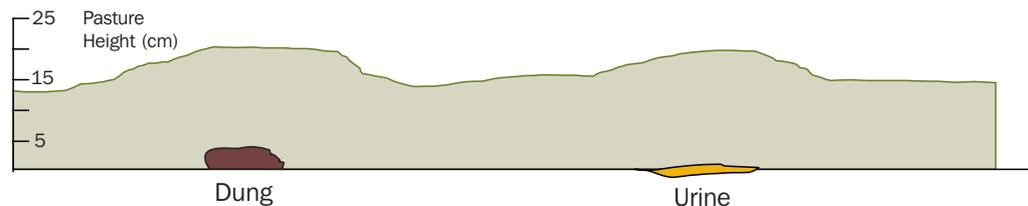
As pasture growth exceeds the animal's requirements, the pasture around the more recent dung pats and urine patches is less closely grazed or not grazed at all. The pasture in between the patches may still be grazed to the desirable levels nominated in the post-grazing residue method, but the heavily grazed areas may be smaller.

Example 1 in Figure 3.3 represents a pasture at the ideal height to introduce stock. Example 2 represents a pasture grazed to levels to maintain pasture growth rates and quality over time. Example 3 represents an under-utilised pasture and is typical of what occurs when pasture growth exceeds animal requirements if the grazing pressure was similar to that of the previous grazing. Note the greater amount of pasture left ungrazed around the dung and urine patches.

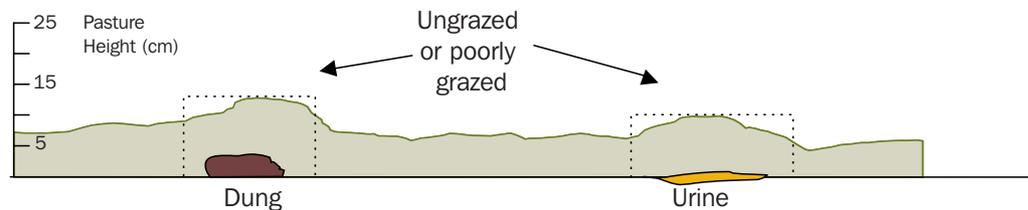
Figure 3.3

Using the grazing of dung and urine patches to identify pasture surpluses.

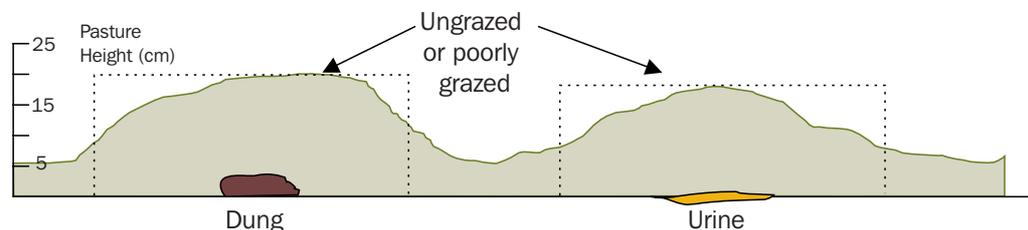
Example 1: Pasture at recommended height to be grazed.



Example 2: Pasture after being grazed to the ideal height.



Example 3: Under-utilised pasture, pasture growth exceeds animal requirements.



Feed budgeting

Feed budgeting is a more effective means of determining the area that should be closed for silage (see Chapter 1, Section 1.4). It is predictive and can be updated as seasonal conditions change. Full feed budgets are not necessary but are often useful where there are many different classes of stock and/or large differences in pasture growth between paddocks. The more complete the feed budget, the more accurate the estimation of pasture production and potential for greater pasture utilisation.

The simplest calculation is to subtract animal requirements from the predicted pasture growth rate to give a percentage of the farm required for grazing over the silage period (see example at right).

Because weather conditions may affect the predicted growth rates, this method needs to be updated weekly if it is to remain accurate. Paddocks can be removed from or brought back into the grazing rotation if

Example (dairy farm)

- Given a stocking rate of 3 cows/ha on the farm, and a feed requirement of 15 kg DM/cow/day
- The amount of pasture required from each hectare is:
 $3 \times 15 = 45 \text{ kg DM/cow/day}$
- Assume the predicted pasture growth rate over the anticipated closure period (allowing for any variation between paddocks) is 60kg DM/ha/day
- Then the proportion of the farm area required for grazing is
 $(45 \div 60) \times 100 = 75\%$

Therefore, by difference, and given these assumptions, 25% of the farm can be closed for silage.

required. In this respect, the feed budgeting method is similar to the post-grazing residue method. Local agriculture department (or equivalent) advisers should be able to provide district average pasture growth rates for use in these calculations. Obviously, seasonal conditions will affect these averages and need to be taken into account.

Section 3.2

Carryover effects of harvesting silage on the pasture

The choice of cutting date will influence silage yield and quality. Although research is limited, evidence suggests that time of silage cut will also affect subsequent pasture productivity. Each of these factors can have an important influence on the profitability of silage production.

3.2.1

Short-term effects on pasture regrowth and quality

Regrowth

The influence of the time of cut on the regrowth of perennial ryegrass-based pastures was covered earlier (see Tables 3.1 and 3.2, Figure 3.1). These studies showed that better regrowth yields were generally obtained when:

- ▶ pastures were closed for silage earlier in the spring; and
- ▶ the duration of closure was shortened to improve silage quality.

Traditionally, the risk of wet weather has

meant that hay is cut later in the season, usually at a later stage of growth. For both these reasons, the regrowth following a hay cut is usually considerably less than that from a silage cut. This is illustrated in two studies at Wagga Wagga, NSW – one with a high-density legume (HDL) forage crop (see Table 3.3) and a second with a mixed annual grass/subclover pasture that also contained a small perennial grass component (see Table 3.4). Early November is the traditional hay cutting time in this environment.

In the second study, a pasture was cut at four times during spring, over three consecutive years, and remained ungrazed from the time of cutting to the end of the growing season (early December). The pasture was typical of many of the degraded pastures in this region, with a low content of sown species and with a relatively low digestibility. Because it contained a high proportion of earlier maturing annual species, the regrowths were considerably less than that obtained from the later maturing forage legume crop in Table 3.3.

Despite the less-than-ideal pasture composition, the combined conservation and regrowth yield, and digestibility of the forage cut for conservation was higher for the early silage cut than for the traditional hay cut in early November (see Table 3.4). The longer-term effects of cutting on the composition of this pasture are discussed in Section 3.2.2.

Table 3.3

Regrowth yields from annual high-density legume (HDL) forage crops* cut for silage or hay at Wagga Wagga, NSW.

	Silage	Hay
Cutting date	8 Oct	6 Nov
Conservation yield (t DM/ha)	3.22	5.31
Digestibility at cutting (% OM)	76.8	69.2
Crude protein content at cutting (% DM)	19.8	12.6
Regrowth yield (t DM/ha)	2.52	0.94
Grazing days (27.5 kg lambs) on regrowth (days/ha)	2329	513

* Mixture of berseem, Persian and arrowleaf clovers. Mean results over 3 years. A second regrowth was obtained after the silage cut in one year.

Source: Condon (2000) and Kaiser et al. (unpublished data)

Table 3.4

Effect of time of cut in spring on the yield at cutting and from the regrowth for a mixed annual grass, subclover and perennial grass pasture at Wagga Wagga, NSW.

	Cutting time and harvest strategy			
	Early Oct (Early silage)	Late Oct (Late silage or early hay)	Early Nov (Traditional hay – district practice)	Late Nov (Late hay)
Yield at cutting (t DM/ha)	4.8	5.0	5.2	4.9
Organic matter digestibility (%)	64.9	60.6	53.7	48.3
Regrowth yield (t DM/ha)*	0.6	0.4	0.1	0
Total spring yield (t DM/ha)	5.4	5.4	5.3	4.9

* From cutting to the end of the growing season (early December).

Source: Bowcher (unpublished data) – mean results for 3 years

Higher-quality pastures on uncut areas

Apart from pasture yield considerations, cutting for silage, when combined with good grazing management practices, also increases the quality of forage for grazing on the remainder of the farm not set aside for silage production. This is due to the higher grazing pressure on the farm maintaining the pastures at a vegetative growth stage for longer. This means that the whole farm forage quality benefits (silage, regrowth and areas not conserved) can be substantial.

The benefit over the whole farm needs to be taken into account when assessing the economic benefits of silage production. The benefit will be greatest where pastures are fully utilised by either grazing or cutting silage. Where significant quantities of surplus pasture remain unutilised, the effect on pasture quality on the uncut area will be reduced.

Other potential short-term benefits

- ▶ Cutting irrigated pastures for silage, rather than hay, allows watering to recommence sooner. The shorter wilting for silage means the pasture is less likely to be moisture stressed. The advantage over hay making could be as much as a 50% increase in pasture growth rate for a 30-40 day period.
- ▶ Silage cutting increases the effective grazing pressure during periods of peak pasture growth, reducing the need for slashing or mulching surplus, rank growth.
- ▶ There is anecdotal evidence for some pastures that early-cut silage, compared to late-cut silage or hay, will improve the composition of desirable species such as clover and perennial grasses in the regrowth.
- ▶ An early first cut as silage from lucerne, to control weeds, can be a viable alternative to chemical weed control and may also increase total production from a lucerne crop over the whole season. The risk of weather damage to the first cut is also reduced where it is cut for silage rather than hay.
- ▶ Regrowth following a silage cut can provide a high-quality pasture, free of internal parasites, for lambs or calves after weaning.
- ▶ In the annual pasture areas of southern Australia, the regrowth following silage can provide sheep with a grazing area free of grass seeds, reducing damage to skins and carcasses, and seed contamination of wool.
- ▶ Silage cutting can remove pasture bulk, leaving an open sward suitable for over-sowing with a pasture or forage crop. This is particularly valuable for the over-sowing of a kikuyu pasture with clover or ryegrass in autumn.

3.2.2

Longer-term effects on pasture

The longer-term effects of conservation cuts on the pasture need to be taken into account when assessing the economics of silage production.

In southern Australia, there is anecdotal evidence that silage cutting can improve the legume content and reduce undesirable grasses and broadleaf weeds. These effects are likely to be influenced by many factors, including pasture species, timing of the silage cut, seasonal conditions, soil fertility and fertiliser application, and grazing management.

The issues related to nutrient removal and cycling, and soil acidification are discussed in Chapters 1 and 4.

Of the limited number of studies conducted, an experiment in Gippsland, Victoria, (see Chapter 1, Table 1.2) showed no differences in the botanical

composition of perennial ryegrass/white clover pastures cut for silage or hay each year for four years.

Another study with an irrigated subclover pasture showed that time of cut for hay production in one year had little impact on pasture availability in either winter or spring in the following year (see Table 3.5). For this pasture, the decision on the best cutting time of cut should be based on the hay/silage yield, its quality and the regrowth following the cut.

Silage cutting can influence longer-term changes in the botanical composition of pastures by influencing the competition between species, e.g. reducing the dominance of grasses over legumes during periods of rapid growth or influencing the seed set of annual species in the pasture.

A good example of the effect of the timing of forage conservation cuts on a pasture containing annual species is shown in Table 3.6 (the data was derived from the experiment in Table 3.4). In this experiment, a mixed annual grass/subclover/perennial grass pasture at Wagga Wagga, NSW, was cut at four stages of growth in spring for two consecutive years. The botanical composition was measured at the beginning of the third spring.

This study showed that there can be large changes in pasture composition as a result

Table 3.5

The effect of time of cut on pasture yield in the following winter and spring from an irrigated subclover dominant pasture at Deniliquin, NSW.

Date of cut	Hay cut (t DM/ha)	Pasture yield in following year (t DM/ha)	
		Winter (July)	Spring (October)
Uncut	–	2.2	4.9
24 Sep	5.2	2.2	4.7
10 Oct	6.7	2.1	4.8
25 Oct	6.9	1.9	4.6

Source: Myers and Squires (1968)

Table 3.6

The effect of grazing by wethers (10 DSE/ha stocking rate) and cutting times on species composition of a mixed annual grass/subclover/perennial ryegrass pasture the third spring after cutting or grazing in each of the two previous springs.

Species	Initial pasture composition (%)	Grazing only	Grazed then cut in spring			
			Early Oct (Silage)	Late Oct (Late silage or early hay)	Early Nov (Traditional hay – district practice)	Late Nov (Late hay)
(% of species in the pasture in Year 3)						
Phalaris + cocksfoot	15.9	15.4	18.4	14.2	14.1	16.6
Subclover	31.4	18.1	36.6	11.6	15.6	19.9
Naturalised clovers	3.9	0.5	4.5	0.3	4.0	6.6
Annual ryegrass	25.1	17.7	28.3	52.8	9.8	9.2
Vulpia (silvergrass)	16.4	26.3	2.0	10.3	53.2	41.3
Great brome	1.0	14.1	2.1	0.2	1.3	3.9
Barley grass	0.3	4.8	0.2	0	0.4	0.1
Paterson's curse	3.5	0.3	6.9	4.4	0.4	1.5
Other broadleaf weeds	2.3	2.7	1.2	6.0	0.8	0.2

Source: Bowcher (unpublished data)

of conservation cuts and that the timing is critical. Considering the species that accounted for a total of at least 70-80% of the pasture, the main changes in pasture composition were:

- ▶ Compared to grazing, the early silage cut significantly increased subclover and annual ryegrass content, and reduced vulpia (silvergrass) content.
- ▶ Compared to grazing, the traditional hay cut reduced annual ryegrass and significantly increased vulpia content.
- ▶ The cutting strategies had little impact on the content of perennial grasses.
- ▶ An early silage cutting strategy may favour an increase in the content of Paterson's curse if regrowth is not managed.
- ▶ Compared to the start of the experiment, all treatments reduced the pasture's subclover content, with the exception of the early silage cut.

In this study, the regrowth was not grazed. Strategic grazing of the regrowths may have influenced seed set for some species and led to an even greater impact on botanical composition.

Vulpia is an unproductive, lower-quality grass, often rejected by grazing animals. Any reduction in vulpia content will benefit pasture production. The early silage cut achieved this with an improvement in subclover content. These changes would be expected to improve both pasture yield and quality, and give significant additional economic benefit in favour of silage production.

As highlighted in Table 3.6, timing of the cut has a major impact on changes to botanical composition. The stage of growth (phenological development) of a species determines its sensitivity to cutting in terms of subsequent growth and seed production. It appears that for control of annual grasses, it is best to cut when the

Plate 3.2

Timing of the silage cut can affect pasture composition. This photograph was taken in early November. The area on the left is the early October silage cut referred to in Table 3.6, while the area on the right is the early November cut treatment, immediately before cutting. Note the high quality regrowth on the early cut area, and the Vulpia population in the later cut.

Photograph: A. Bowcher



most advanced seed head is between post-flowering and early seed fill.

For control of Paterson's curse, the best stage appears to be when the earliest (lowest) seeds on the most advanced flowering head have reached the very early green seed formation stage (seed formation is visible in spent flowers).

Further research is needed to provide clear guidelines on the critical stages of growth for various species. This will allow farmers to identify the optimum growth stage at harvest for both desirable and undesirable species in pastures. This will be more reliable than setting cutting dates by a calendar, a method subject to regional variations and seasonal variations between years.

If silage cutting is to be used to manipulate the botanical composition of a pasture, there may be occasions where this objective could lead to pastures being cut later than if the focus was on silage quality alone. In such situations, farmers need to weigh up the relative benefits of changes in silage quality and longer-term changes in pasture composition.

Section 3.3

Weed control

A successful weed management strategy relies on a vigorous, competitive pasture to replace the targeted weed species. If the pasture is not competitive, another weed species will invade the space.

3.3.1

Weed control versus silage quality trade-off

Grasses

There is clear evidence from the study detailed in Table 3.6 that silage production can have an important role in reducing the content of grass weeds such as vulpia in pastures. Farmers have also reported that silage reduces the content of Yorkshire fog grass in perennial pastures.

The presence of grass weeds in a pasture is not likely to influence the silage fermentation because their sugar content

and buffering capacity are likely to be similar to that for pasture grasses (see Chapter 2, Section 2.1.3). In addition, most grass weeds, if cut early, are likely to have a medium to high digestibility.

Consequently, the presence of grass weeds is not likely to have a major impact on silage quality in an early-cut system.

However, as indicated earlier, the digestibility of all species in the pasture will suffer if cutting is delayed to control a particular grass weed.

The seeds of some grass species can be a problem with a later harvest. Although the seeds are rendered non-viable by the ensiling process, they can cause wool contamination problems (Plate 3.3), and barley grass seeds can cause mouth ulcers in cattle fed short chopped silage (Plate 3.4a and b).

Broadleaf weeds

There is anecdotal evidence that silage cutting can reduce the content of some broadleaf weed species in pasture, although there is little research data available. It is generally assumed that silage making controls these weeds by reducing or preventing seed set, and/or sterilising any weed seeds that are present.

Plate 3.3

When pastures are cut late for silage or hay, grass seed contamination of wool can be a problem.



Photograph: K. Kerr

Plate 3.4a and b



Mouth ulcers (on the tongue, gums, inside the cheek, and on the roof of the mouth) developed in cattle given a short chopped oaten silage contaminated with mature barley grass seeds.



Photograph: J. Piltz

Given these potential broadleaf weed control benefits, and the general presumption that ensiling will improve the palatability or attractiveness of the weeds to livestock, there is the temptation to use silage making as a control strategy for these weeds. However, a high proportion of broadleaf weeds in a silage could reduce silage quality (see Table 3.7). This could occur in the following ways:

- ▶ The broadleaf weeds can have a lower digestibility than pastures cut early for silage. Quite small changes in silage digestibility can have a significant effect on animal production.
- ▶ Broadleaf weeds may have lower initial DM content than the pasture species or thicker stems, which can slow their drying rate. A slow, extended wilt can reduce silage quality.
- ▶ Some broadleaf weeds, particularly capeweed and Paterson’s curse, have a high buffering capacity (see Chapter 2, Section 2.1.3). This will slow the rate of pH fall in the early stages of the ensiling process, increasing the risk of a poor silage fermentation and subsequent rejection of the silage by the animals.

Each of these broadleaf weed characteristics could reduce silage digestibility, intake and animal production. If silage cutting is to be used to control broadleaf weeds, there is likely to be a trade-off between any control benefits and silage quality. In addition, delaying a silage harvest to coincide with the optimum time of cut for broadleaf weed control will result in lower silage digestibility.

Another issue that has not been investigated is the risk of poisoning when toxic weeds are ensiled. It is not known whether the toxins in some Australian broadleaf weeds are deactivated during the ensiling process, so it is wise to be cautious and seek veterinary advice before ensiling forages heavily contaminated with weeds known to be toxic.

Research is needed to compare the potential benefits in controlling both grass and broadleaf weeds using silage conservation, with the potential animal production penalties. This will provide clear guidelines for producers on the acceptable level of weed contamination in silage, and when it is appropriate for farmers to modify silage management to control weeds.

Table 3.7

	Subclover pasture	Capeweed	Paterson’s curse	Variegated thistle
DM content at cutting (%)	15.4	12.1	12.9	13.0
Organic matter digestibility (%)	71.1	68.0	62.6	68.9
Crude protein (% DM)	16.2	12.0	12.6	12.6
WSCs (% DM)	12.2	17.0	12.9	15.5
Buffering capacity (meq/kg DM)	852	1202	1027	691

The chemical composition of subclover pasture compared to three broadleaf weeds cut for silage in spring at Wagga Wagga, NSW.

Source: Kaiser (unpublished data)

3.3.2

Weed seed viability in silage

It is generally assumed that the ensiling process makes most weed seeds non-viable and that weed seeds are not spread in the way they are with hay feeding. Producers and researchers have based this assumption on observations, but there are no supporting Australian research data.

A Canadian study (see Table 3.8) has examined the effects of ensiling on weed seeds in some detail. In this study, none of the grass seeds survived the ensiling process – no seeds germinated or were viable. While germination levels were very low with the broadleaf weeds, viability varied from 3 to 30%, indicating that, under favourable conditions, at some point in the future these seeds could germinate.

Other studies have shown that ensiling prevents the germination of broad-leafed dock (*Rumex obtusifolius*).

The available evidence from these studies indicates that while germination of broadleaf weeds is severely restricted, the seeds of some weeds may remain viable after being ensiled.

Research is required to clarify the situation for common Australian weeds. The important issue is the effect of different ensiling conditions in Australia on weed seed survival. Conditions that may have an effect include silage fermentation, wilting and duration of storage.

Table 3.8

The effect of ensiling on the germination and viability** of weed seeds.#*

Weed		Effect of ensiling
Botanical name	Australian common name	
Grasses		Both germination and viability reduced to nil
<i>Echinochloa crus-galli</i>	Barnyard grass	
<i>Bromus tectorum</i>	–	
<i>Hordeum jubatum</i>	–	
<i>Setaria viridis</i>	–	
<i>Avena fatua</i>	Wild or black oats	
Broadleaf weeds		Germination reduced to 0-2% and viability to 3-6%
<i>Chenopodium album</i>	Fat hen	
<i>Descurainia sophia</i>	–	
<i>Amaranthus retroflexus</i>	Amaranth	
<i>Thlaspi arvense</i>	Pennycress	Germination reduced to 0-5% and viability to 10%
<i>Kochia scoparia</i>	–	
<i>Malva pusilla</i>	Mallow	Germination reduced to 0-3% and viability to 23-30%
<i>Polygonium convolvulus</i>	Black bindweed or climbing buckwheat	

* Germination is the percentage of seeds that sprouted when subjected to a standard germination test.

** Viability includes the percentage of seeds that germinated as well as those that have potential to germinate when conditions are favourable.

In this study, seeds were ensiled for 8 weeks in bunkers of barley silage with DM contents of 33-36%.

Source: Adapted from Blackshaw and Rode (1991)