

Silage in the farming system

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The authors

B.M. Doonan¹,
A.G. Kaiser²,
D.F. Stanley³,
I.F. Blackwood⁴,
J.W. Piltz² and
A.K. White³

1. Department of Primary Industries, Water and Environment, Devonport, Tasmania
2. Department of Primary Industries, Wagga Wagga Agricultural Institute, Wagga Wagga, NSW
3. Department of Primary Industries, Cowra Agricultural Research and Advisory Station, Cowra, NSW
4. Department of Primary Industries, Tocal Agricultural Centre, Tocal, Paterson, NSW

The Key Issues

- Focus on increasing profitability, targeting high-quality silages and reducing wastage.
- Silage can be used to increase productivity, improve pasture management and provide greater management and marketing flexibility. Key benefits for most grazing industries are:
 - increased production/ha through an increase in stocking rate;
 - increased production/head;
 - improved product quality; and
 - increased capacity to supply markets with specified products at designated times.
- When incorporating silage into a production system, take a whole farm perspective. Key questions are:
 - Why silage? What is the production or management goal?
 - Is surplus feed available for silage production, or can it be grown or purchased?
 - Is silage the most cost-effective way to meet the production/management goal?
 - How will silage influence other activities on the farm?
- At an operational level, integrating silage into the production system is basically a feed budgeting exercise.
- The main economic issues are economies of scale, justification of capital investment and the potential for saving labour.

Section 1.0

Introduction

Successful livestock management involves matching the supply of feed with the animals' requirements as efficiently and profitably as possible. The aim is a product that meets market specifications when the market wants it.

Although grazing is the lowest-cost animal production system in Australia, it may not necessarily be the most profitable. In most regions, seasonal shortages in the quantity and/or quality of feed available for grazing limits production.

Most dairy, lamb and beef production systems are based around grazing, but feed supplements are often required to meet production targets. Forage conservation can fill feed gaps by transferring high-quality feed from periods of surplus to times of deficit. Silage is an ideal forage conservation method for this purpose.

For each producer considering the silage option or changes to their silage system, the issues can be condensed into questions in four key areas:

1. Why silage? What is your production or management goal? How are you going to change your production system to pay for, or make a profit from, your silage operation?

2. Do you have surplus feed or can you grow (or buy) additional forage for silage production?
3. Is silage the most cost-effective strategy for meeting your goal?
4. How will silage influence, either positively or negatively, other activities on your farm?

Evaluating the potential role for silage within a farming enterprise involves a number of issues that will influence farm management and planning. These can be both strategic and operational:

Strategic: Silage's role in improving farm business profitability in the longer term.

Operational: Incorporating silage into the farming system, on a daily basis, to manage feed gaps and feed surpluses.

Some of the key strategic issues that need to be considered are:

- ▶ the impact on the growth and profitability of the farming business;
- ▶ the ability to supply a product when it is required and that meets market specifications;
- ▶ the implications of seasonal variations in pasture availability and quality;
- ▶ planning for variations in feed availability between years, e.g. guarding against exceptional circumstances, such as drought or flood;
- ▶ improving the utilisation of available forage when it is at a high-quality stage of growth;
- ▶ the role of silage as a pasture management tool; and
- ▶ integrating silage with other activities or enterprises on the farm.

The principles associated with integrating a successful silage program into the farming system are similar between farms and grazing enterprises. Some industry-specific issues are covered in more detail later in this chapter.

Plate 1.1

This pasture is under-utilised. Conserving surplus growth and better grazing management would improve utilisation.

Photograph: Department of Agriculture, WA



Section 1.1

Trends in forage conservation in Australia

Production of hay and silage has increased significantly during the past century (see Figure 1.1).

Assuming a market value of \$100/tonne for hay and \$45/tonne for silage, on an 'as fed' basis, the average value of the hay produced each year between 1996 and 2000 was \$542 million. The figure for silage was \$108 million a year.

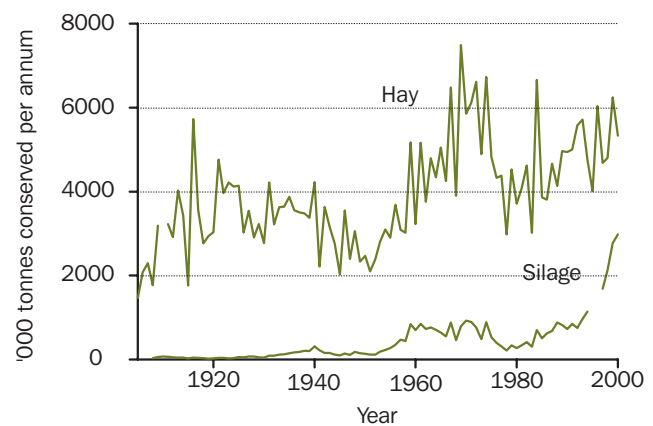
Most of the hay and silage is used on the farm on which it was produced. However, there is significant trading of hay and, in recent years, there has been some trading of silage and crops for silage production, particularly in the beef feedlot sector and the dairy industry.

Hay and silage production has varied considerably between years. Hay is clearly the dominant form of forage conservation, with production peaking in 1969. From 1970 to 2000, annual hay production has been between 3.7 and 6.7 million tonnes a year. Silage production grew rapidly during the 1990s; annual production reached about 3.0 million tonnes in 2000.

There has been significant growth in silage production in each of the grazing industries during the past decade, although detailed statistics are only available for the dairy industry (from a recent ABARE study). Average silage production per dairy farm increased from 64 tonnes in 1991/92 to 142 tonnes in 1999/2000; over the same period, hay production rose from 97 to 114 tonnes.

Figure 1.1

Annual hay and silage production in Australia.



Source: Australian Bureau of Statistics

Factors driving the increased adoption of silage

- A need to improve pasture utilisation and increase productivity.
- Capacity to cut earlier in the season, produce a higher-quality product and spread the harvesting time over a longer period than with hay.
- Valuable role of silage as a pasture management tool.
- Improved silage-making technology (e.g. wilting, plastics, additives) that make the process more reliable.
- Improved harvest mechanisation and availability of a diverse range of harvesting and storage systems.
- Improved mechanisation of silage feeding systems, reducing labour requirements and wastage.
- Increased focus on consistency of product supply and quality, and the need to supplement animals for 'out-of-season' production.
- Reduced susceptibility to adverse weather (rain) compared to hay, particularly early in the season.
- Reduced conservation losses compared to hay.
- The possibility of silage production with a much wider range of crops, that in some enterprises can lift productivity to levels higher than that possible with pasture alone.
- The suitability for long-term storage for a drought or flood.

Section 1.2

Hay and silage compared

There is clear evidence from a number of studies that the digestibility and crude protein of silages made on farms are higher than for hays. This is borne out in the results from feed testing laboratories (see Chapter 12, Appendix 12.A1). (The advantages of silage are highlighted in the text box on the previous page.)

A beef production study in WA showed an advantage in favour of a silage system compared with the conventional hay system, at three levels of grain feeding (see Table 1.1). Adjacent annual ryegrass/subterranean clover pastures were cut for silage on 10-11 October or for hay on 6 November. (Cutting hay earlier in this environment is not practical due to the high risk of rain damage.)

The advantages of the silage system were:

- ▶ higher forage quality – DM digestibility (68.5 versus 60.9%), estimated ME content (9.7 versus 8.6 MJ/kg DM), and crude protein content (15.1 versus 8.1% DM) were all higher for the silage;
- ▶ steer liveweight gains and feed efficiency (kg gain/t feed DM) were better on the silage diets (see Table 1.1).

The silage's higher ME and crude protein content, and shorter particle length, would have contributed to the improved liveweight gain:

- ▶ Higher ME content, and perhaps an improved efficiency in the use of available energy, are likely to be the main advantages in favour of silage in this study.
- ▶ The low crude protein content of the hay-based diet (due to the hay's low crude protein content) would have inhibited growth at low levels of concentrate feeding, but not at the high level of concentrate feeding, where cattle gained at 1.20 and 0.88 kg/day on the silage and hay respectively.
- ▶ The silage was chopped (using a forage wagon) and this may be an advantage in terms of higher intake compared to longer particle length of hay (see Chapter 14, Section 14.2.5).

A four-year study of perennial grass dominant pastures (perennial ryegrass and cocksfoot) in a dairy production enterprise in Gippsland, Victoria, found superior milk production was obtained from a silage compared to a hay system (see Table 1.2).

Table 1.1

Growth of steers (initially 277 kg) on hay and silage produced from an annual ryegrass/subclover pasture in WA, and given various levels of concentrate.

	Hay (5.6 t DM/ha)			Silage* (5.0 t DM/ha)		
Concentrate in diet (% liveweight)**	0.5	1.0	1.5	0.5	1.0	1.5
DM intake (kg/day):						
Forage	4.36	3.86	2.82	4.99	4.26	3.58
Concentrate	1.39	2.90	4.47	1.45	2.94	4.39
Total	5.75	6.76	7.29	6.44	7.20	7.97
Liveweight gain#:						
kg/day	0.33	0.63	0.88	0.81	1.09	1.20
kg/t feed DM	57	93	121	126	151	151

* Silages were made with and without an enzyme additive. There was no effect of enzyme additive on animal production.

** Concentrate comprised 67% barley, 30% lupins and 3% minerals.

Liveweight gain from the mixed diets.

Source: Adapted from Jacobs and Zorilla-Rios (1994)

Table 1.2

	Silage farmlet	Hay farmlet
Average cutting date	28 October	7 December
Quantity of forage cut each year (t DM)*	11.4	10.4
DM digestibility of the conserved forages (%)	69.8	61.4
Milk production – commencement of feeding to end of lactation:		
Milk (L/cow**)	1,178	925
Milk fat (kg/cow)	54.5	41.9
Milk production – whole lactation:		
Milk (L/cow)	4,380	4,049
Milk fat (kg/cow)	190.8	170.5

* Additional surplus forage was conserved as hay in Year 4 on the silage farmlet and is included here, but is not included in the means for cutting date or digestibility.

** To convert milk production from L/cow to kg/cow, use the equation in the 'Milk production' entry in the Glossary.

A comparison of milk production from silage and hay systems on perennial grass-based pastures in Gippsland, Victoria.

Source: Adapted from Thomas and Mathews (1991). Mean results for four years

The silage system allowed an earlier cutting and produced conserved forage of higher digestibility than the hay system.

If the silage system had not suffered a high level of loss, the advantage of the silage system would have potentially been greater. Losses of 26% were reported for the small experimental stacks, compared to typical losses of only 7% in well-sealed commercial silage stacks in the district. The losses in the experimental stacks included the storage component and losses from the exposed face during feedout (aerobic spoilage). Aerobic spoilage can occur in small experimental stacks where there is a slow rate of feedout, and leads to high DM losses and reduced silage quality (see Chapters 2 and 9).

There is also evidence of a milk production advantage for silage when hay and silage are cut from the same crop on the same day. In a number of American studies with lucerne cut at various stages of growth, milk production was consistently higher for cows fed a mixed silage/concentrate diet (see Table 1.3). This reflects the higher DM and quality losses in the field and during harvesting with hay compared to silage. The hay and silages in these studies were produced under good drying conditions – a greater advantage in favour of silage would be expected under adverse weather conditions. The milk production differences would probably have been even greater if lower levels of concentrate were fed.

Table 1.3

Study	Conservation method	Concentrate in diet (%)	Stage of maturity at harvest			
			Early bud	Mid-bud	Early flower	Full-late flower
1	Hay	45	26.6		25.5	25.5
	Silage	45	27.2		27.0	27.7
2	Hay	40		30.7	32.1	
	Silage	40		33.6	33.4	
3	Hay	40	35.0		36.0	
	Silage	40	38.1		37.0	

Milk production (kg/day) from cows given hay or silage made from the same lucerne crop.

Source: Nelson and Satter (1990, 1992)

Section 1.3

Impact of silage on the farming system

There are a number of long-term implications for whole farm management when silage is first incorporated into the production system or significantly expanded. These can be thought of in terms of increasing land productivity, efficiency of resource use and management control over production.

Increased land productivity may occur through pasture or replacement of some pasture with forage crops. Efficiency gains may occur in the use of land, water, nutrients and capital. Greater management control enables the desired product to be sold on time.

Greater flexibility and new marketing opportunities

Silage production may provide new options, such as:

- ▶ potential for new or supplementary animal enterprises on the farm;
- ▶ sale of surplus crop/pasture/silage;
- ▶ finishing or opportunity feedlotting cattle and sheep for slaughter (including purchase of additional animals);
- ▶ ability to change calving or lambing time to improve reproductive performance and produce ‘out-of-season’ product for high-value markets;

- ▶ ability to target new markets; and
- ▶ better integration of existing enterprises, such as animal production and cropping.

Possible management changes for the current animal production enterprise

The decision to produce silage, or expand the use of silage in livestock enterprises may lead to other changes on the farm, such as:

- ▶ changing the cropping rotation to grow specialist silage crops;
- ▶ increasing fertiliser use to maximise yield and replace nutrients removed by silage cuts;
- ▶ changing irrigation strategies to meet grazing and silage-making demands;
- ▶ increasing stocking rates to utilise conserved forage;
- ▶ reducing reliance on irrigation for forage production for grazing and on supplementary feeds such as grain or hay;
- ▶ potential to improve water use efficiency on irrigation farms; and
- ▶ modifying the drought or flood risk strategy.

The Key Principles for a successful silage program

On any farm where silage is made, there are three key principles that should be the focus of a successful silage program. These are emphasised throughout this publication.

- 1. Improved economic decision making:** There is increasing pressure for management decisions to be economically justified. Decisions concerning silage use should not be made in isolation of other activities on the farm – a ‘whole farm’ approach is essential. Farmers need to be aware of the costs and potential returns for silage, and a strong emphasis is needed on improving economic performance. Chapter 11 looks at the economic decision-making process.
- 2. Improving quality:** It is almost always better to have a lower yield of a higher-quality silage than to compromise silage quality in order to maximise the quantity of forage harvested per hectare.
- 3. Reducing losses:** One of the key factors affecting the cost of silage are the losses that can occur at each stage of the production process – in the field, during storage, and during feeding out. There can be losses in both quality and quantity. Losses must be minimised to improve the economic performance of silage systems.

Pasture management

Most silage produced on farms is from surplus pasture or specifically grown crops. Silage production can be integrated with grazing management to:

- ▶ manage pasture surpluses and so improve pasture utilisation;
- ▶ provide higher quality forage by cutting early for silage and utilising regrowth after silage making, and by allowing more grazing pressure on the rest of the farm;
- ▶ increase pasture production by maintaining pastures at a more active growth stage longer through increased grazing pressure;
- ▶ improve weed management through strategic cutting to reduce the production of viable weed seeds;
- ▶ reduce the need for slashing (or mulching) on some farms to maintain pasture quality; and
- ▶ close paddocks or reduce the grazing pressure on pastures at critical time(s) of the year by strategic feeding with silage to improve the survival and productivity of desirable pasture species.

The last point is particularly relevant in southern Australian where late autumn ‘breaks’ often result in poor pasture growth during winter. Reducing grazing pressure allows the pasture to more quickly increase leaf area, thereby increasing growth rates and production over winter. Depending on the pasture species, growth rate is optimised at pasture heights of 5-10 cm.

Chapter 3 covers the integration of silage production with grazing as a pasture management tool in greater detail.

The planning process

When these whole farm implications have been considered at the individual farm level, technical and operational issues need

to be taken into account, including:

- ▶ the cost of silage compared to alternative feeds;
- ▶ land, machinery, buildings and labour requirements associated with silage use;
- ▶ planning and logistical issues such as the efficiency of feeding systems, and the siting of silage storage and feedout facilities;
- ▶ the quantity of silage required – number of animals to be fed, duration of feeding and proportion of silage in the diet;
- ▶ silage quality targets – the level of animal production required;
- ▶ the choice and cost of the silage production and feeding systems;
- ▶ management required to optimise silage quality;
- ▶ management required to minimise harvest, storage and feedout losses; and
- ▶ a plan for ongoing monitoring (quality assurance) of the silage operation.

When farmers are confident that the use of silage is technically feasible, and that all the implications of incorporating or expanding the use of silage in the farming system have been considered, they then need to investigate the economic viability of this strategy (see Chapter 11).

Plate 1.2

Rapid growth of tropical grasses in summer often results in poor utilisation. Integrating silage production with grazing management, although not widely practised, may improve the utilisation of these pastures (see Chapter 4, Section 4.9).

Photograph: M Martin



Section 1.4

Integrating silage into the farming system

1.4.1

Developing a feed budget

Developing a feed budget for the farm will identify pasture surpluses and feed deficits, and allow an assessment of the potential role for silage. A feed budget is often used to outline the feed supply and demand at monthly intervals over 12 months – a feed year plan. Historical records can be used to budget for year-to-year variations, to cover the risk of poor seasons, drought, extremely wet conditions and flood.

The simplest feed budget will compare daily pasture growth rate with daily animal requirements (see Figure 1.2). This approach does not account for carryover standing pasture or variations in pasture quality.

There are substantial differences between regions and pasture types in the seasonality of pasture production in Australia. In addition, differences between animal production enterprises and market requirements can mean that pasture supply and animal requirements are ‘relatively’ well matched, as in Figure 1.2, or very poorly matched when peak demand coincides with a period of poor pasture growth or quality. In many cases, it is

usually pasture quality rather than quantity that limits animal production.

On most farms, there is marked seasonal variability in both pasture quality and growth rate (quantity). As plants mature and progress from a vegetative through to a reproductive phase, growth rate slows and quality declines (see Figure 1.3).

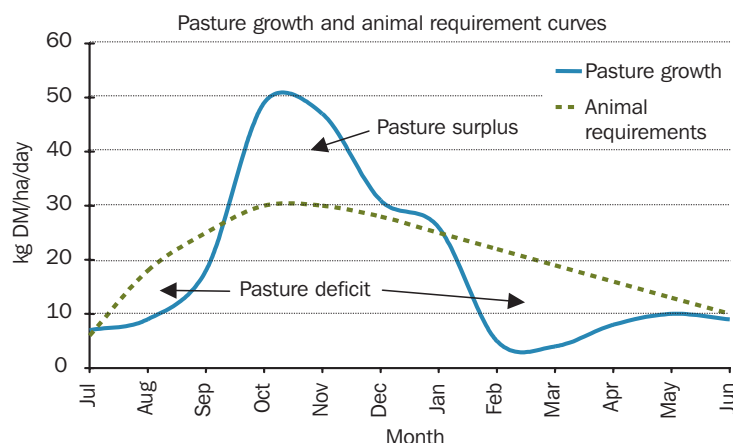
Feed budgeting must account for pasture quality as well as quantity. This can then be matched to estimated animal requirements, which are based on the number and class of livestock to be fed and the production targets. The resulting budget will indicate when the pasture can adequately meet animal requirements.

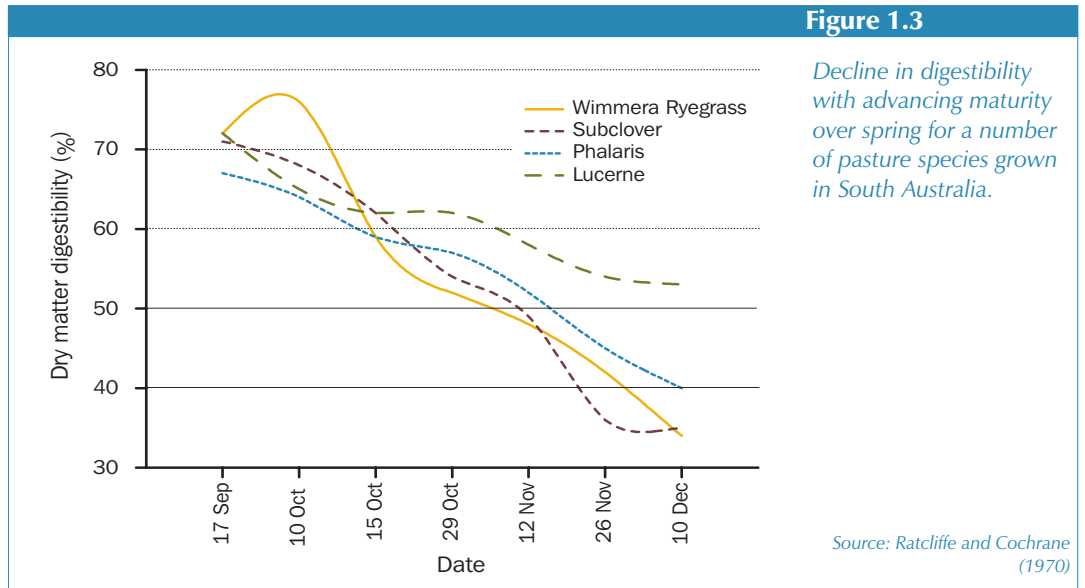
Using information from the feed budget, farmers can determine when supplementation is required to meet production targets or prevent dramatic loss of body condition. In some cases, loss of production or condition is acceptable; supplementation is not required to maintain overall productivity. This can occur at various stages in the production cycle in beef and sheep enterprises, e.g. some loss of condition in breeding stock, provided it is not severe and animals calve or lamb in good condition, may have little effect on animal production.

Figure 1.2

Annual feed budget for a temperate perennial pasture-based dairy farm in Tasmania, stocked at two cows per hectare, and with a seasonal calving.

Note: This example is for a high stocking rate dairy enterprise in Tasmania. Some cows would be off-farm when they are dried off, hence the low demand in June–July. Intakes in other dairying regions would generally be higher than indicated here.

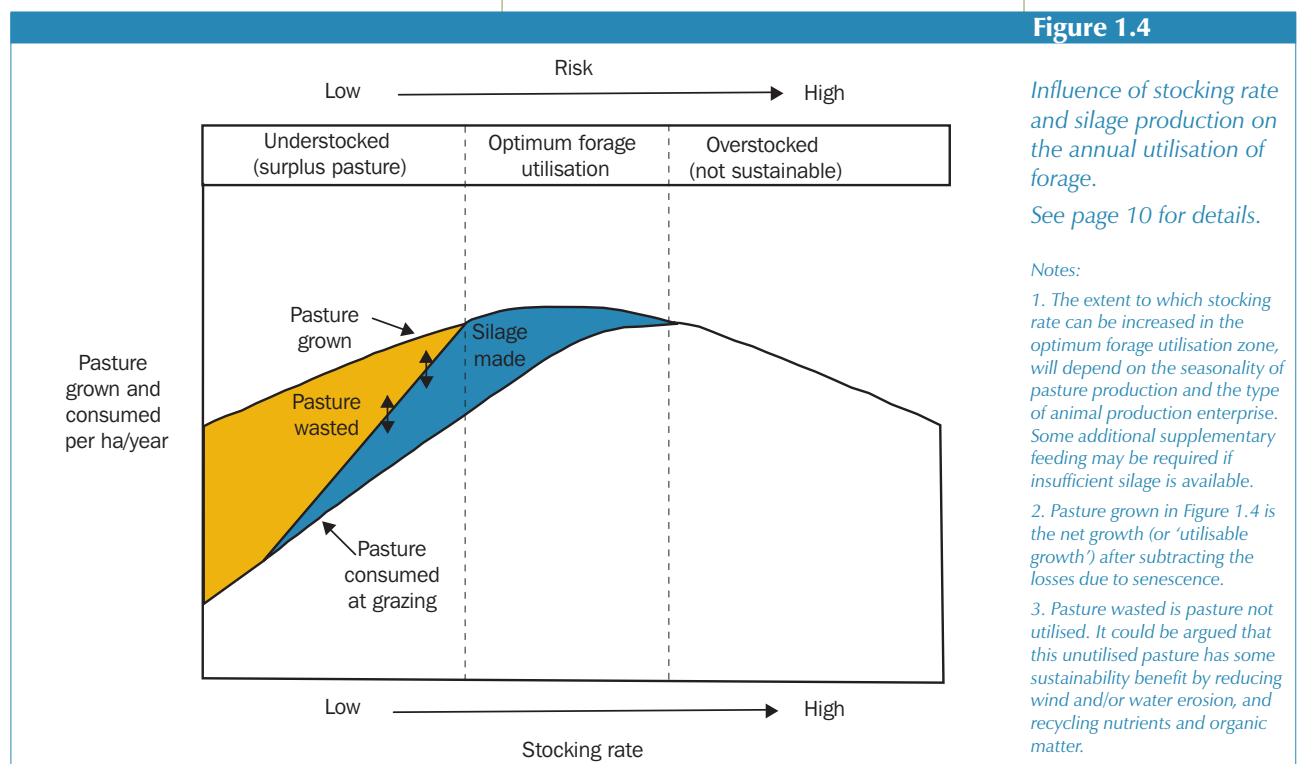




Feed budgets can also be used to assess the adequacy of various management or intervention strategies to improve the balance between animal requirements and pasture supply – varying stocking rate, calving/lambing dates, stock trading, increasing pasture growth (fertiliser, irrigation) and supplementary feeding strategies (including silage). An example of this use of feed budgeting is provided in Section 1.5.1 (see Figure 1.6). This same approach is used to evaluate silage management issues, such as closure date,

duration of closure period, mowing date and their subsequent effect on pasture production and quality (see Chapter 3).

Various feed budgeting tools are available for the grazing industries in each State. Advisers from the various State agriculture departments have access to many of the computer-based programs. The Tasmanian Department of Primary Industries Water and Environment (DPIWE) created the feed budgets in Figures 1.2 and 1.6 from a simple feed budgeting program (DPIWE Feedbudgeting Program).



1.4.2

Factors influencing the amount of silage produced on a farm

Stocking rate and the seasonality of pasture production and quality are the two main factors affecting the amount of forage that can be conserved on a farm. Increasing the stocking rate reduces the quantity of surplus feed, and therefore the amount of forage available for conservation as silage (see Figure 1.4), increasing the need for feeds from outside the farm to complement pasture. Any feed deficit that existed before stocking rate was increased is likely to increase as well.

The relative size of periods of pasture surplus and deficit (the seasonality of forage availability) will affect the level of silage produced on farm. For example, annual temperate pastures in southern Australia have a marked seasonality of the pasture growth, with a very large surplus in spring and significant deficits in pasture quantity and/or quality during late summer, autumn and winter. There is a high potential to increase animal production by transferring surplus spring pasture, at a high-quality stage of growth, to other times of the year.

Many farming systems use very conservative stocking rates as a risk management strategy to cope with periods of lowest feed availability. As a result, pasture is often considerably under-utilised during periods of high growth. Increasing stocking rate for short periods, when there is surplus pasture available, is often not practical or economically feasible. This can create large deficits at other times of the year, which must be addressed by the purchase of additional supplements or by de-stocking. Both options have the potential to decrease farm profit if not properly evaluated and managed.

Producers can use a combination of silage production and an increase in stocking rate to optimise the utilisation of forage during the 12-month production cycle indicated in Figure 1.4. This also allows grazing intensity (effective stocking rate) to be increased during periods of rapid pasture growth, maintaining the forage at a higher quality, vegetative stage of growth for longer.

At low stocking rates, where some of the surplus pasture is conserved as silage, producers can increase stocking rate with a low risk of a feed shortfall, secure in the knowledge that silage is available as a buffer.

When all available pasture is utilised by a combination of grazing and silage production, producers are entering the high risk zone. Any further increases in stocking rate can only occur at the expense of the quantity cut for silage. As stocking rate increases and the opportunity for silage production decreases, there is a greater risk of a feed shortage due to adverse seasonal conditions. This risk can be lowered by the use of other supplements. An alternative is to choose the lower stocking rate end of the optimum forage utilisation zone in Figure 1.4. This is a lower-risk strategy that achieves optimum utilisation of the forage grown each year; stocking rate is reduced marginally and more silage is cut.

As can be seen from Figure 1.4, there is a relatively narrow range of stocking rates at which pasture conservation will give a substantial benefit to production. The type of animal production system, the desired level of animal production per head, and economics are all important considerations.

1.4.3

Time of cut – management implications

High-quality silage is produced from pastures and crops cut early, in the late vegetative to early reproductive growth stages, before forage quality deteriorates with advancing plant maturity (see Chapter 4, particularly Figure 4.3, and Chapter 5). This will ensure high levels of animal production from silage (see Chapters 13, 14 and 15).

The potential pasture management benefits of silage production are discussed in detail in Chapter 3. Benefits will vary with the pasture type, but the growth stage of the pasture at harvest is critical in determining the extent to which pasture productivity is improved. An early harvest usually produces the best total production response from the pasture (silage yield plus regrowth). However, if optimum weed control is the goal, a delayed harvest may be necessary.

Achieving a particular pasture management goal, such as weed control, may result in a lower quality silage. In these situations, the pasture management benefits need to be weighed against the animal production lost due to the reduction in silage quality. An additional consideration is the reduced flexibility in feeding, with the use of lower-quality silages being limited to those parts of the production cycle when the animal's nutrient requirements are lower, e.g. dry stock in early pregnancy.

1.4.4

Purchasing silage

It may be necessary to import fodder to increase animal production on farms where stocking rates are already high and all available forage is being effectively utilised.

Buying silage, or crop for silage, can provide producers with greater management flexibility. However, the profitability of this strategy needs to be thoroughly assessed, taking account of the forage's nutritive value and DM content, and transport and handling costs (see Chapters 11 and 12). Farmers should also ensure that any bought feed is free of chemical residues and weed seeds.

1.4.5

Other considerations

A number of economic factors need to be considered when integrating silage into the production system. These are covered more fully in Chapter 11.

- ▶ Introduction of a silage system can affect the farm's capital structure. Although a new system may improve the gross margin, the farm profit may not improve if the production increase is eroded by increased overhead costs.
- ▶ The capital cost of machinery ownership can have a significant impact on silage-making costs. Producers need to consider whether they should buy mowing and harvesting equipment, share ownership (syndicate) or use a contractor.
- ▶ In many cases, expenditure on facilities to reduce storage and feedout losses, and an efficient feedout system, may be the best initial investment of capital set aside for forage conservation.

Section 1.5

Silage in dairy, beef and sheep enterprises

It is critically important that the silage operation be integrated into whole farm management and not viewed in isolation. Silage is a means to an end, not an end in itself.

There are many potential roles for silage in grazing systems. These are summarised in Table 1.4. Their relative importance will vary from enterprise to enterprise, and from region to region.

Table 1.4

The role for silage in various livestock enterprises.

Silage use	Dairy	Beef	Lamb	Wool
Improve animal product quality or market compliance through the use of silage supplements	✓	✓✓✓	✓✓✓	✓✓
Improve capacity to supply animal product when required ('out-of-season')	✓✓✓	✓✓✓	✓✓✓	
Provide opportunity to access new markets or develop complementary enterprises	✓	✓✓✓	✓✓✓	✓
Increase stocking rate	✓✓✓	✓✓✓	✓✓✓	✓✓
Supplement to increase production/head	✓✓✓	✓✓✓	✓✓✓	✓
Change calving or lambing time (and calving or lambing %)	✓✓	✓✓	✓✓	✓✓
Improve weaner survival or growth of replacement animals	✓	✓✓	✓	✓✓
Drought, flood or bushfire reserve	✓✓	✓✓	✓✓	✓✓
Improve pasture management and utilisation	✓✓✓	✓✓✓	✓✓✓	✓✓
Weed management/control	✓	✓✓	✓✓	✓✓
Reduce dependence on irrigation	✓✓✓	✓	✓	✓
Reduce dependence on purchased feed	✓✓✓	✓✓	✓	✓

✓✓✓ Very important ✓✓ Moderately important ✓ Relevant on some farms

Note: Silage is not likely to be important in the more extensive beef enterprises in northern Australia, or in the more extensive wool enterprises in the low rainfall rangeland areas.

1.5.1

Dairy

Conservation of surplus pasture and specialty crops as silage can play an integral role in matching feed supply with requirements, improving pasture utilisation and management, and profitability on dairy farms. Chapter 13 covers the utilisation of silage in dairy feeding systems in greater detail.

Production benefits

- ▶ An increase in the yield, quality and utilisation of pasture grown (see Chapter 3). This will improve milk production per cow, increase stocking rate and increase ‘whole farm’ productivity.
- ▶ Transferring forage from times of surplus to times of deficit reduces the need to buy other supplementary feeds to sustain milk production. For example, on a typical Queensland dairy farm conserved forage is used to overcome feed deficits in the March to August period (see Figure 1.5). As production systems intensify, the

current trend is for the silage component of the diet to increase at the expense of grazed pasture. In southern Australia, silage is used to fill quantity or quality feed gaps in late summer, autumn and winter.

- ▶ A portion of the farm can be set aside to grow high-yielding, high-quality specialist crops for silage, increasing the total amount of forage produced on farm. This can lead to a further increase in stocking rate.
- ▶ Purchasing pasture or crop for ensiling on farm is becoming a useful strategy for dairy farmers who are already fully utilising their forage resources, enabling them to expand their business without having to outlay capital to buy additional land.
- ▶ Silage can be the key feed resource that allows dairy farmers to expand and intensify their production system. Better economies of scale can be achieved by using silage to increase milk production on the farm, reducing overhead and labour costs per litre of milk produced.

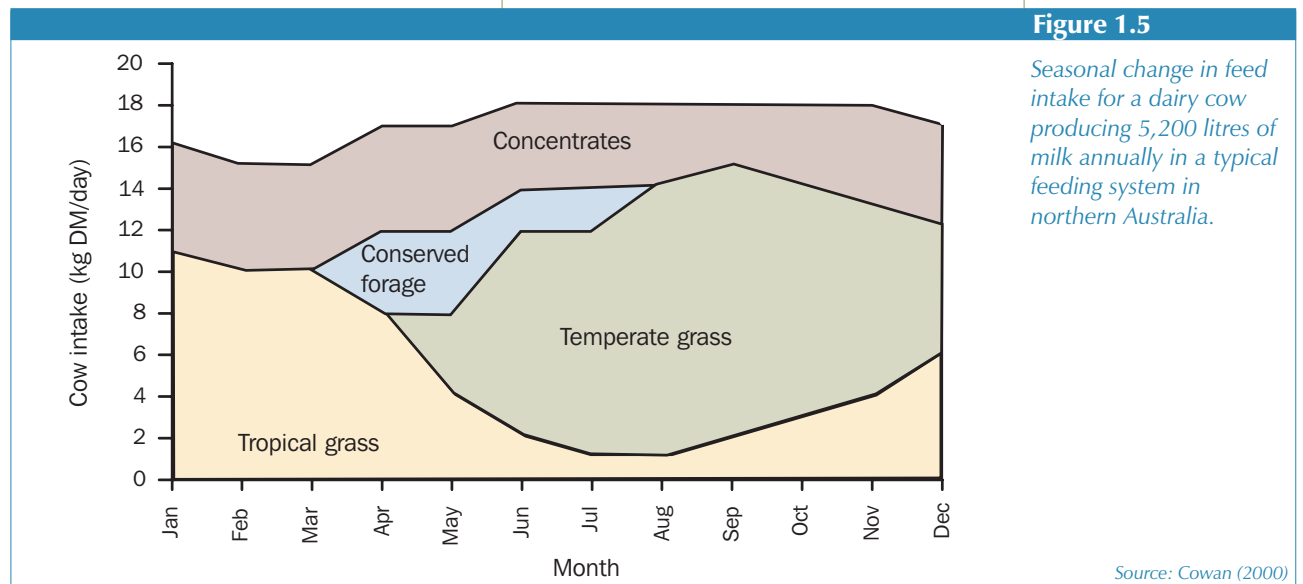


Figure 1.5

Seasonal change in feed intake for a dairy cow producing 5,200 litres of milk annually in a typical feeding system in northern Australia.

Source: Cowan (2000)

Additional benefits

- ▶ Silage can be used as a supplement for replacement heifers when pasture supply and quality is insufficient to ensure adequate growth rates before joining.
- ▶ In many situations, it is more efficient to use available water to produce crops than pasture. Producing silage during favourable times of the year can reduce reliance on irrigation to produce pasture for grazing. This water is then available to higher-value crops such as maize.
- ▶ Irrigation water may be more effectively used by irrigating during spring or autumn when evaporative losses are lower, rather than during a hot, dry summer. In many areas, surplus forage can be produced more cheaply during these periods, and conserved as silage for later use.
- ▶ Silage can be used to balance the dietary intakes of dairy cows by supplying fibre to cows grazing lush

pastures or receiving concentrates.

Legume silages can be used to supply additional protein to cows consuming low-protein feeds, such as maize or sorghum silage.

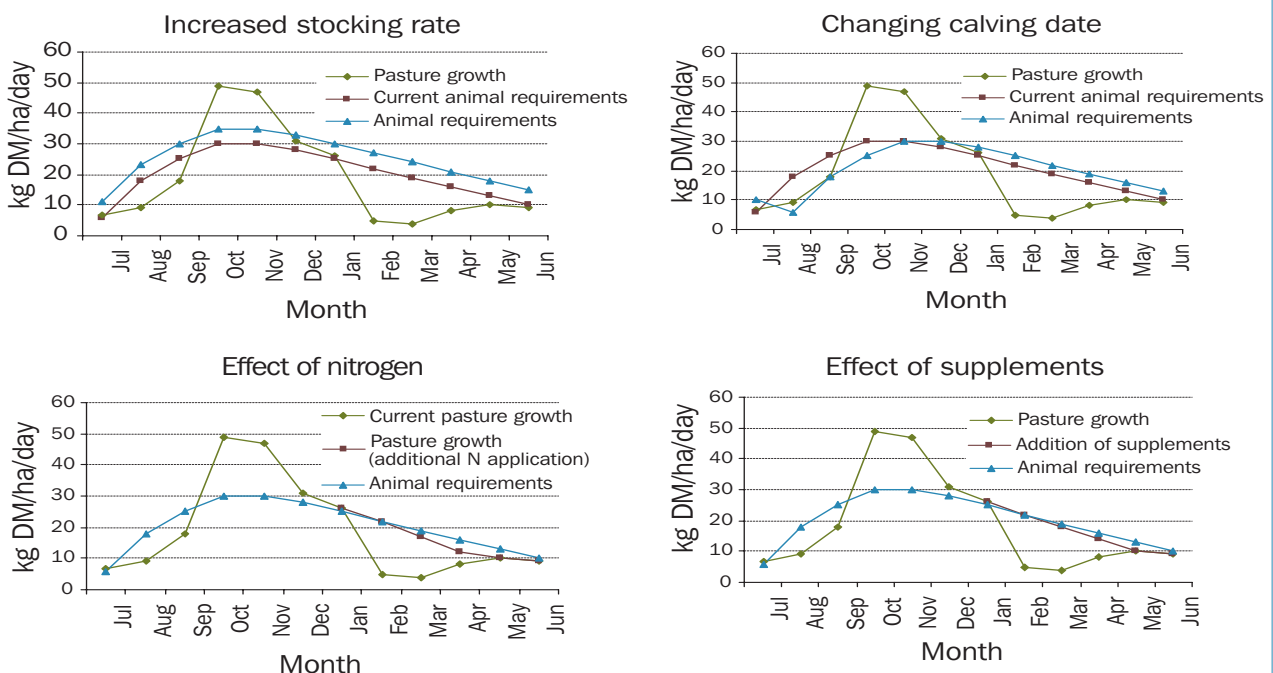
- ▶ Where there are price incentives to produce ‘out-of season-milk’, silage can provide the feed needed for the required change in calving time.
- ▶ Silage can be a valuable drought, flood or bushfire reserve.
- ▶ Silage can be used as a replacement or ‘buffer feed’ to allow grazing management objectives to be achieved without a significant penalty in milk production.

How much silage to conserve

The optimum level of conservation on a dairy farm will depend on the balance between animal requirements and pasture growth, with any surplus being available for silage production. Management changes on the farm, such as increased

Figure 1.6

The effect of different management strategies on pasture supply and animal demand.



Example

At a stocking rate of two cows per hectare and an average predicted pasture growth rate through the silage period of 45 or 100 kg DM/ha/day what proportion of the farm should be cut for silage?

	Example 1*	Example 2**
Predicted pasture growth rate	45 kg DM/ha/day	100 kg DM/ha/day
2 cows/ha consuming 15 kg DM/cow/day	30 kg DM/ha/day	–
2 cows/ha consuming 20 kg DM/cow/day	–	40 kg DM/ha/day
Pasture available for silage production	15 kg DM/ha/day	60 kg DM/ha/day
Amount required for grazing	$(30/45) = 66\%$	$(40/100) = 40\%$
Amount available for silage	$(100\% - 66\%) = 34\%$	$(100\% - 40\%) = 60\%$

* Example 1 relates to the feed budget presented in Figure 1.2.

** Example 2 represents the situation likely to occur in a high-production situation.

stocking rate, changing calving time, applying N fertiliser, and feeding supplements, can influence the availability of a surplus (see Figure 1.6).

Methods to determine the appropriate level of conservation on a farm are covered in greater detail in Chapter 3.

A balance is needed between under-harvesting and suffering reduced pasture quality and utilisation, and over-harvesting and restricting cow intake. The most appropriate way to decide the proportion of the farm that should be cut for silage is to estimate average animal requirements and pasture growth rate over the period of surplus pasture growth. Pasture growth in excess of animal requirements can be targeted for silage (see examples above) –

in this case an increase in stocking rate should be considered (see Figure 1.4).

As paddocks are dropped from the grazing rotation, monitoring should continue to adjust animal requirements and actual pasture growth rates for seasonal conditions.

Conclusion

Silage can be used to increase dairy farm profit if it is integrated into the dairy system, if silage production is properly managed to guarantee a high-quality product and silage losses are minimised. Where pasture is the cheapest source of forage, only genuine surpluses should be harvested. A predictive tool such as a feed budget should be used to estimate the area of the farm that can be cut for silage.

Dairy: determining the role for silage

The following series of questions need to be addressed:

1. What is the business goal? How much milk does the farmer want to produce?
2. What is the current feed supply?
3. What is the deficit in feed supply?
4. How much of this feed deficit can be covered by home-produced silage? Note that silage is only a means to an end (more feed) and there are other feed options, which may be cheaper.
5. If there is still a feed deficit can silage or forage (to make silage) be purchased nearby?
6. What is the cost of production for the new system? Taking account of all variables, labour and overhead expenses, what is the total cost/litre milk?
7. Compared to the milk price, is it profitable?

This same approach should be used to assess any proposed change to the production system.

1.5.2

Beef

The challenge is to consistently meet selected market specifications, on time, and with a high proportion of cattle falling within the specifications for carcass weight, fat cover and meat quality.

Silage is one of the supplementary feeds that can be used to achieve production goals. It is suitable for all classes of cattle, including calves from three months old.

Chapter 14 provides a more detailed coverage of feeding silage to beef cattle.

Roles for silage in beef enterprises

Full production feeding

Silage can be fed as the sole diet or with concentrates. It is suitable for use in large-scale or small, on-farm opportunity feedlots. Temporary feedlotting may occur in paddocks where pasture availability is severely limited and represents only a small proportion, probably <10%, of total intake.

Supplementary feeding

There are a number of situations where silage can be used as a supplement to pasture, filling gaps in the quantity and/or quality of pasture available:

- ensure adequate nutrition for cows prior to calving;
- meet cow requirements during early lactation when nutritional demands are high (this can be critical in ensuring fertility and maintenance of the calving pattern, particularly in more marginal grazing areas);
- maintain growth rates of weaners and young, growing cattle to meet market specifications for slaughter or feedlot entry; and
- maintain heifer growth rates to ensure fertility, particularly in more marginal areas where poor growth rate may mean that heifers do not conceive until they are more than two years old.

Drought feeding

Producers should always aim for high quality when conserving silage as a drought reserve. High-quality silage is cheaper to produce, on an energy basis (see Chapter 11, Section 11.3.5), and allows increased management flexibility (see Chapter 14, Section 14.5).

Depending on the available reserves, silage can be used to maintain breeding stock and finish growing cattle for sale. A feed budget should be prepared to determine the numbers of cattle that can be fed for maintenance or for production, and those which need to be sold because they cannot be adequately fed.

Silage made on-farm is a valuable source of high-quality roughage and is usually much cheaper than hay purchased during a drought.

Having sufficient reserves of silage allows cattle to be fed in small ‘sacrifice’ paddocks, protecting the rest of the farm from overgrazing.

Other strategic supplementary feeding

There are a number of other situations where full or supplementary feeding with silage can improve cattle management, production and health:

- Calves can be fed in holding yards at weaning. This is most effective when the calves have been fed silage while still with the cows.
- Silage can be fed to cattle as part of a pre-conditioning program, prior to feedlot entry.
- Silage supplementation will reduce the risk of bloat in cattle grazing lucerne or legume-dominant pastures.
- Silage supplementation will reduce the incidence of grass tetany in cattle grazing young, lush pastures.

Production benefits

Most beef enterprises have marked seasonal variation in pasture production and quality. Much of the surplus DM produced during the period of peak pasture growth is not utilised because stocking rates usually reflect the number of stock that can be carried over the whole year. Utilisation of the total annual production from a pasture can be as low as 30-40% of the potential.

Beef production per hectare may be increased if surplus, high-quality pasture is cut for silage, although this will depend on stocking rate (see Figure 1.4) and beef prices. Estimates of the potential beef production per tonne of forage and per hectare are provided for a range of pastures and crops in Table 1.5.

Integrating silage into a beef enterprise has a number of potential benefits:

- ▶ One of the main options for silage use is to increase stocking rate – and production per hectare – without changing the production per head or the market specifications for the animals being sold. Producers can either increase the size of their breeding herd or increase the number of animals turned off from a steer-growing enterprise.
- ▶ The other main option for silage use is to increase production per head, thereby increasing production per hectare. A higher proportion of the current turn-off can be finished for sale or slaughter, or turned off earlier and/or at higher weights, independent of prevailing pasture conditions. This will improve the producer's capacity to supply the target market. If the objective is to turn off animals at a younger age, this resulting reduction in the effective stocking rate will provide an opportunity to run more stock.

Some producers will choose a combination of the two options above.

Table 1.5

Pasture or crop	Silage yield (t DM/ha)	Potential liveweight gain (kg)	
		per t DM	per hectare
Phalaris/subclover pasture (single cut in spring)	4	115	(460)**
Oat/vetch crop	12	110	1,320
Perennial ryegrass pasture (single cut in spring)	4	120	(480)
Lucerne (from each cut)	3.2	120	(384)
Forage legume crop	6	125	750
Grain sorghum crop (dryland)	5.5	115	633
Maize crop (irrigated)	20	130	2,600

* Estimates based on a range of agronomic and animal production data from the literature.

** Values in brackets are from a single silage cut only. Total production per hectare needs to take account of the beef production generated by grazing the regrowth from these pastures.

*Estimated beef production from silages produced from various pastures and crops harvested at a high quality stage of growth.**

Additional benefits

Within a beef enterprise, silage can also:

- ▶ act as a pasture management tool, improving pasture productivity and composition, and reducing weed content (see Chapter 3);
- ▶ reduce the reliance on purchased supplementary feeds (purchased hay can be low in quality and is often more expensive per unit of energy or protein fed than silage produced on-farm);
- ▶ provide the supplementary feed that may be required to change calving time, allowing producers to target higher-value markets at alternative times of the year or improve reproduction rates (calving percentage); and
- ▶ provide producers with the flexibility to target cattle for alternative markets (e.g. heavy grass-fed steers for the Korean market, which is not feasible in many pasture-based enterprises in Australia).

Conclusion

Incorporating silage into a beef enterprise has the potential to increase farm profitability if the silage is of high quality and losses are kept to a minimum.

A target ME content of 9.5-10 MJ/kg DM or higher is essential if high levels of beef production per tonne of silage, and per hectare, are to be achieved.

The two key areas where silage will have the most impact will be an improvement in production per head (improved compliance with market specification, achieved earlier) and an increase in stocking rate.

Beef: determining the role for silage

1. Set clear production goals for the physical and financial components of the beef enterprise. Identify the areas that need change.
2. Assess the forage (pasture, crop, conserved forage) resources available on the farm:
 - When will surplus forage be available for silage production?
 - What silage quality can be achieved from the available forage?
 - Will the quality/quantity match that required for the new production system?
3. Is silage the best strategy for providing the additional feed required for the changed production system?
4. Will silage use change turn-off times, allow access to higher prices, or incur extra costs? Will these need to be budgeted for in a cash flow assessment?
5. How will the new system influence overheads and labour requirements?
6. What is the impact on the cost per kg beef produced from the farm, and how does this compare with beef prices – is it profitable?

1.5.3

Sheep

The challenge for sheepmeat producers is to ensure that market specifications are met. Chapter 15 provides a more detailed coverage of feeding silage to sheep.

Roles for silage in sheep enterprises

Silage produced from surplus pasture, or specialty crops, can be used to increase stocking rates, supplement growing lambs, feed pregnant and lactating ewes, and to finish older surplus sheep. However, silage use is not restricted to prime lamb producers. Wool producers, particularly those in more favourable environments, where forage conservation is more widely practised, can use silage to increase stocking rate, provide improved nutrition to lambing ewes to improve weaner survival and growth rates during periods of pasture deficit, finish prime Merino lambs, sheep for live export and cast-for-age stock.

Some producers are now retaining lambs for 2-3 months longer to meet preferences for heavier weights, which often requires the use of supplementary feeding. It is also possible to finish older, cull sheep through the use of supplements. The sale of cull sheep can contribute 15 to 25% of gross income from sheep and wool enterprises.

Matching feed and animal needs

The majority of lambs are produced in southern Australia, which has a winter rainfall pattern and an often unreliable autumn break. Pasture growth is slow in winter, but surplus feed is usually available in spring, which is followed by a dry summer. Although this pasture growth pattern complements an autumn joining, in about 25% of years heavy lambs cannot be produced unless supplementary feed is used. Later lambing usually necessitates

carryover of lambs through summer, for marketing in autumn.

Producers have the option of summer pastures/crops, such as lucerne and/or irrigation, or they may accept slow growth rates on lower quality pastures. In many cases, supplementary feeding or feedlotting will be necessary to meet minimum growth rates and production goals. The use of conserved silage, either alone or with grain, provides a source of supplementary feed to achieve these goals.

Lambs produced in summer rainfall areas will also have feed deficit periods at other times of the year that must be managed.

Because grazing is the cheapest form of feeding, it is important to match the high ewe requirements with the pasture production cycle. A fodder budget can be used to compare animal requirements with pasture production and quality.

The following example is for a higher rainfall (900 mm) grazing property of mixed native and sown pastures and specialty pastures such as lucerne or chicory. Ewes are joined in autumn and stocked at 5/ha (8.5 DSE/ha). The GrazFeed® model (see Figure 1.7) predicts two periods when feed is not sufficient for animal production – ewes in late pregnancy (August) and lambs post weaning (January/February). Silage can be made from the spring surplus for later supplementation. In this example, lambs and ewes are fed a mixed silage and grain supplement.

Silage can be used in 'normal' seasons, often in conjunction with grain, when insufficient high-quality pasture is available. Table 1.6 shows situations when silage might be used.

There are obvious management alternatives to forage conservation, such as reducing animal demand by selling lambs at lighter weights or growing specialty

Table 1.6

Probable timing of silage supplementation of lamb production enterprise in temperate zones of Australia, at two times of joining.

Class of sheep requiring silage supplement	Autumn lambing flock	Winter/spring lambing flock
Ewes	March-May	May-July
Ewes with lambs	May-August (drought)	Usually not required
Lambs only	November-December	November-December & February-March

crops. An economic assessment is required to determine the most profitable option (see Chapter 11).

For example:

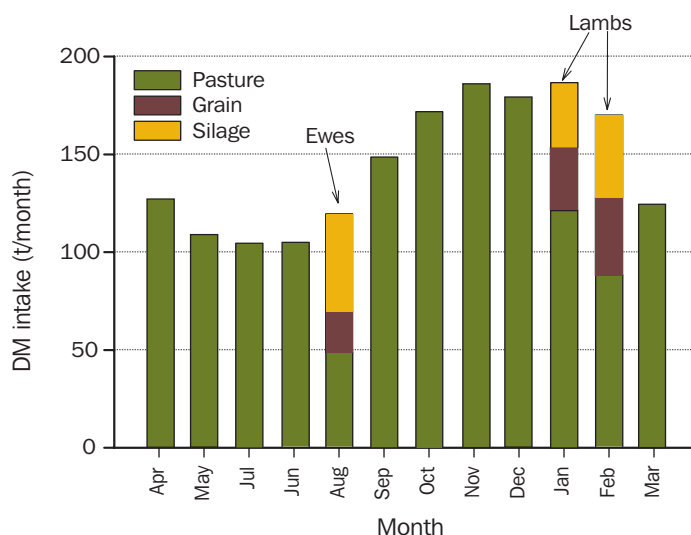
- ▶ By marketing the male lambs on the domestic market at 40 kg rather than 48 kg liveweight, the feed deficit for January and February is halved. The decision will depend on carcase and skin values, and feed costs – are feeding costs more than the increase in carcase and skin value?
- ▶ The feed deficit may also be reduced by marketing all lambs as stores once they reach a minimum of 32 kg (below this they have low commercial value). While this action would remove the need for summer feed of spring lambs, in most cases it would not be economically viable, unless the store lambs are sold to a specialist finisher within an alliance structure where some ownership could be retained.

Production benefits

- ▶ Silage production allows improved utilisation and production of pastures, with the additional feed being used to increase the carrying capacity (number of ewes).
- ▶ Silage can be used to fill feed gaps. Silage produced on-farm has the potential to be cheaper than alternatives, such as grain.
- ▶ Cutting silage enables grazing pressure to be increased over the whole farm during periods of peak pasture growth. This allows pastures to be maintained at a higher quality, vegetative stage of growth, for longer (see Chapter 3).
- ▶ Silage can be used for all classes of sheep as the sole diet, either as a maintenance feed (drought) or for production feeding, particularly when finishing lambs. Growth rates are adequate from good-quality silage when fed alone, but improved animal production can be achieved by adding grain (see Chapter 15, Section 15.1.1).

Figure 1.7

Monthly feed requirements, predicted from the GrazFeed® model, for a prime lamb enterprise in a high rainfall environment, on the central tablelands of NSW. Silage (150 t) is produced from surplus pasture in October.



- ▶ Wool quality can be improved by better grazing management and strategic supplementation to avoid sudden feed changes and subsequent problems with staple strength.
- ▶ The high-quality regrowth that usually follows a silage cut, provides high-quality grazing for lambs late in the season when other pastures are maturing. This 'clean' regrowth can be used as part of a management strategy to reduce internal parasite burdens and grass seed problems.
- ▶ Improvements in pasture productivity and composition, and management of weeds will contribute significantly to the economic benefits from silage in grazing and cropping enterprise.
- ▶ Risk is reduced, with silage providing an option to finish lambs profitably when conditions are dry and unfinished lambs are discounted. It is also easier to fulfil market contracts.
- ▶ The availability of silage provides producers with the option to opportunistically purchase and finish feeder lambs.

Additional benefits

- ▶ Silage provides a stable price alternative to grain, which is usually more expensive in dry seasons.
- ▶ Silage reduces the impact of drought, particularly at higher stocking rates. The availability of a silage reserve can reduce damage caused by over-grazing of pastures and the environmental consequences of drought and other natural disasters, such as bushfires and floods.
- ▶ Silage is a safer feeding option compared to high-grain diets, with reduced risk of animal health problems, such as acidosis.

Conclusions

Profitable use of silage within a sheep enterprise will depend on the production of high-quality, well-preserved silage.

The main benefits are the ability to increase stocking rate and produce more lambs, to finish lambs to specification more quickly and reliably, and to target the preferred heavy lamb market.

The additional benefits of improved pasture management and wool quality help to economically justify silage production.

Sheep: determining the role for silage

1. Clearly identify production goals for the farm business in terms of numbers of lambs and specifications to be targeted.
2. Identify the forage (pasture, crop and conserved forage) resources available on the farm.
 - How much surplus forage is available for silage production?
 - What silage quality will be produced from the available forage?
 - Will the quantity/quality match that required to meet production targets?
3. What additional feed is required to meet the new production goal(s)?
4. Is silage alone (or in combination with grain) the best strategy for providing the additional feed? What are the alternatives and how do they compare economically?
5. What are the benefits (direct and indirect) and costs of the proposed silage system?
6. How will the new system influence overheads and labour requirements on the farm? Economies of scale can be important here.
7. What is the impact on the cost of production (per lamb or per kg) on the farm, and how does this compare with the price received – is it profitable?

Section 1.6

Longer-term implications of forage conservation

In the mixed grain/animal production farming belt, silage is not only of value to the animal enterprise as a supplementary feed and a pasture management tool, but can also provide significant benefits to the grain enterprise. These benefits include weed control during the pasture phase, and weed control and nitrogen fixation when annual forage legume break crops are used for silage production.

1.6.1

Weed control

Weed control can be a significant cost in the pastoral and cropping regions.

Although the development of herbicide resistance in grass weeds, such as annual ryegrass and wild oats, is not a major problem for the grazing industries, it is becoming a serious problem in cropping regions.

Broadleaf weeds can often be expensive to control in pastures if selective herbicides are needed to avoid damage to the legume component. In the cropping areas of southern Australia, wild radish (*Rhaphanus raphanistrum*) is a major problem and farmers are looking to control measures being applied during the pasture phase on farms with crop and animal enterprises.

Strategic silage cutting, either alone or in combination with grazing, provides farmers with another weed control option, reducing the requirement for herbicides. Cutting pastures or annual forage legume crops in spring in southern Australia can significantly reduce seed production in annual weeds (see Chapter 3, Section 3.3). It is generally accepted that most viable seeds present in the cut forage will be sterilised during the ensiling process.

However, most weed seeds will survive the hay-making process and can be spread around the farm wherever hay is fed.

Timing of the silage cut in spring is critical to significantly reduce weed seed production. The optimum time of cut will vary with the target weed and should be related to the stage of weed development (see Chapter 3, Section 3.3). A strategic crash grazing of the regrowth may be required if there is any regrowth of the target weed.

Some annual forage legume crops suitable for silage production have the added bonus of competing effectively with weeds and suppressing their establishment and growth through autumn and winter. For example, peas and vetch sown at high rates, preferably with a low cereal sowing rate (see Chapter 5, Section 5.4), have been found to suppress annual ryegrass in studies at Wagga Wagga, NSW.

1.6.2

Soil acidification

All producers should be aware of the possible long-term effects of the removal of agricultural products from a farm, whether it be grain, forage, meat, milk or wool, on soil acidity. Acidification rates vary between soil types and production systems, with greatest concern for declining pH being on naturally acid (low pH) soils under high production systems. Soil tests should be used to monitor soil pH. Lime application may be required to counteract a decline in soil pH. If soil pH is allowed to fall below critical levels, production will suffer.

Table 1.7 shows indicative lime requirements for a number of silage parent crops. Note that acidification rates will be higher when the forage has a high legume component.

The majority of silage is fed back onto the farm (perhaps not on the same paddock), so the question arises as to whether this system is any more exploitative than one which removes the same quantity of forage by grazing. For example, the acidifying effects of a silage cut may be less if the silage is fed back on that paddock. Long-term studies are required to investigate these issues of nutrient cycling, removal and transfer.

1.6.3

Nutrient cycling, removal and transfer

Large quantities of nutrients are removed when crops and pastures are harvested for silage (see Chapter 4, Table 4.2, and Chapter 5, Table 5.1).

To achieve a sustainable farming system, redistribution of nutrients must be taken into account when silage is fed to animals – the portion that is recycled via excreta and that which is exported off-farm in animals and animal products.

Most nutrients, including phosphorus and potassium, are available to plants through fertiliser inputs or the soil’s natural fertility. Nitrogen fixation by legumes makes nitrogen unique.

The cycling of nitrogen is highlighted in the following exercise, where high-quality legume silage is fed for beef or lamb production on a mixed livestock/crop farm. In both systems, approximately 70% of the silage nitrogen is excreted by the animals in dung or urine, while the remaining 30% is retained in the animal and is exported off-farm when the animals are sold.

In the grazing situation the nitrogen is returned directly to the paddock, but the nitrogen in silage is transferred to the paddock where the silage is fed. By controlling the site of feeding, producers can decide where the nitrogen is returned. The transferred nitrogen may be used to

Table 1.7

Product removed	Lime rate (kg lime/t product removed)
Lucerne hay	60
Mixed pasture hay*	30
Subclover	41
Maize**	24

The equivalent rate of lime required to balance the acidifying effect of product removal.

Sources:
Slattery et al. (1991);
** Kaiser and Piltz (1998a)

* Predominantly grass species, <20% clover.

boost the fertility of pasture paddocks or those to be cropped. Nutrient redistribution by livestock complicates the issue and should be taken into account.

The simplified version of the nitrogen cycle in Figure 1.8 illustrates the effect of the options outlined on the previous page, using a mixed farming system as the example. Losses of nitrogen from the system, due to volatile losses or leaching down the soil profile, although important, are not included.

The main features of the cycling, transfer and loss of nitrogen from this mixed farming system are:

- ▶ The quantity of nitrogen fixed by legume pastures and forage crops (and remaining in soil) is generally considered to be approximately 20 kg of nitrogen for each tonne of total legume forage DM produced (grazed and ensiled).

- ▶ The nitrogen content of the legume cut for silage is approximately 3% of the DM (or 30 kg N/t silage DM). Therefore, for legume pastures or forage legume crops yielding silage cuts of 4.5 t and 7.5 t DM/ha, the quantity of nitrogen in the silage for each hectare cut would be about 135 and 225 kg, respectively.
- ▶ If 30% of the silage nitrogen is exported off-farm in animal product, the nitrogen remaining on-farm, either recycled or transferred, would be approximately 95 and 158 kg nitrogen for each hectare of legume pasture or forage crop cut for silage, respectively.
- ▶ Feeding the high-quality silage on a stubble paddock to be cropped next season would not only provide the animals grazing poor-quality stubble with a high-quality, high-nitrogen supplement, but also transfer a significant quantity of nitrogen that could be utilised by the subsequent crop.

Figure 1.8

Simplified description of nitrogen (N) cycling, transfer and removal when legume silage is integrated into a mixed grain/animal farming system.

