



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

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Feeding silage to sheep

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Feeding silage to sheep

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The Key Issues

- Silage has many potential roles in sheep enterprises. It can be used to improve pasture utilisation, increase animal production per head and/or increase stocking rate.
- Conserving high-quality forages will maximise potential livestock production per tonne of conserved silage. Compared to low-quality forages, conserving high-quality forage reduces silage-making, storage and feedout costs per unit (MJ) of ME. For this reason it is also more cost-effective to conserve high-quality forage as a drought reserve.
- Good fermentation quality is essential to ensure high DM intake and therefore sheep production.
- Most silages used in Australian sheep production systems will be produced from temperate crops and pastures, and, with good management throughout the whole silage-making process, the energy (ME) content should exceed 10 MJ/kg DM.
- To maximise animal production from silage it is essential to wilt most parent crops or pastures. This must be done rapidly, to the target DM content (35-50% DM). Wilting to higher DM contents will increase field losses and reduce silage quality. Storing silage at DM levels <30% increases the risk of poor silage fermentation and quality loss due to effluent production.
- Additives can improve fermentation quality, silage recovery and animal production and may improve the aerobic stability of the silage. Additives are likely to be of most economic benefit when the silage is fed to responsive animals, e.g. growing lambs for the sheepmeat trade.
- Supplementation with grain will increase total DM intake and lamb liveweight gain when using silage-based diets to finish lambs. Protein supplementation may also improve intake and liveweight gain. Higher rates of grain supplementation will be required when feeding lower-quality silages.
- Short chop length will increase intake of chopped silages. Where there is no restriction on access to baled silage there may be no penalty of long chop length because sheep can 'graze' the silage, effectively reducing the length of particles consumed. Poor accessibility due to competition for space may reduce intake and therefore production.
- High-quality silage supplements fed to grazing sheep can be used to increase production from individual animals, increase stocking rate or extend pasture availability.
- Silage can be a useful management tool to maintain pasture quality and avoid husbandry problems, e.g. grass seed contamination and worm burdens.
- Feeding silage or silage-based diets to lambs for meat production will produce high-quality carcasses and meat.

Section 15.0

Introduction

The potential roles for silage in various sheep enterprises have been discussed in Chapter 1 (see Section 1.5.3) and are considered only briefly here. From the summary in Table 15.1, it can be seen that the main roles for silage are in feeding growing lambs and lactating sheep, in prime lamb enterprises and in self-replacing flocks in wool enterprises, and as a drought reserve for all classes of livestock. Whatever the enterprise, it is important that producers clearly define their production and management goals before deciding how silage will be integrated into their whole farm operation. The primary focus should always be silage quality, as this determines the potential animal production per tonne of silage DM. However, because yield of the parent forage will impact on total production per hectare, there must be a balance between yield and quality (see Chapters 4 and 5). One of the key roles for silage in a sheep enterprise is as a pasture management tool, improving pasture utilisation and management (see Chapter 3). Production, from all classes of sheep, is limited by rank pasture growth. Any management strategy, including silage production, that prevents pastures (particularly perennial grasses) from becoming rank, or that minimises the risk of grass seed damage will benefit both wool and sheepmeat enterprises.

Silage can also be used to increase stocking rate by transferring available feed from periods of surplus pasture growth to periods of feed deficit. On some occasions this may result in reduced production per head, but production per hectare may still increase (see Chapter 1).

It is usually not cost effective to supplement adult sheep for increased wool production per head. However, there may be a role for silage to increase staple

strength. Reduced staple strength often occurs following the autumn break in southern Australia and is associated with an increased rate of wool growth when green feed becomes available.

Supplementation with silage for 2-3 months before the autumn break will ensure that animals are receiving a more constant plane of nutrition, preventing this rapid increase in the rate of wool growth.

Another potential role for silage in self-replacing Merino flocks is as a supplement to increase profitability through improved reproductive performance (ensuring ewes reach target weights at joining) and improved weaner nutrition.

Basic nutrition and diet formulation are not discussed in this manual and the reader is referred to sheep nutrition publications. Computer programs such as GrazFeed® or Takeaway® can be used to estimate supplementary feeding requirements for various classes of sheep. Programs such as ProPlus allow producers to create their own fodder budgets on a whole-farm basis.

GrazFeed® estimates animal production responses from available pasture and predicts responses to supplementation. The program is available through Horizon Agriculture, <www.hzn.com.au>

Takeaway® calculates the least cost rations for ruminant animals on a supplementary or fully fed basis. For more details, see <www.pir.sa.gov.au>

ProPlus is NSW Agriculture whole farm fodder budgeting program, available from NSW Agriculture livestock officers.

Plate 15.1

Silage is a suitable supplement for ewes to maintain bodyweight and milk production if paddock feed availability declines. Photograph: D. Stanley



Producers not only have to consider the nutritional requirements of sheep when feeding silage, other issues such as silage fermentation quality, chop length, and

feedout management are important if the production potential of the silage is to be achieved.

Table 15.1

Potential roles for silage in sheep enterprises.

Class of sheep	Feeding objective(s)	Comments
Finishing prime lambs	To ensure that lambs meet market specifications for liveweight and fat cover. Target particular high value markets such as 'out-of-season' lamb or heavy export lamb.	<i>Supplementary feeding:</i> Possibly the most common use. The quantity and quality of available pasture, and any other supplements provided, will determine the amount of silage to be fed. Can be used to reduce reliance on pasture and increase stocking rate. <i>Full feeding:</i> Can be used in a feedlot, although more often in small paddocks with minimal pasture cover. Usually fed with grain to maximise intake and growth rates. In both cases the silage must be high quality and capable of sustaining high levels of intake.
Supplementation of ewes	May have various objectives: <ul style="list-style-type: none"> • flushing ewes before joining; • ensuring adequate nutrition before lambing to prevent pregnancy toxemia; • maintaining ewe bodyweight and milk production after lambing; • changing lambing time; • ensuring adequate nutrition to by maintain consistent wool quality preventing breaks; and • filling feed gaps and increasing stocking rate. 	The level of silage supplementation will depend on the quantity and quality of available pasture. Silages should have a high ME content and adequate protein to optimise animal response. Silage can provide the supplementary feed required to implement a change in lambing time. This may allow an improvement in lambing %, or allow producers to supply lambs when market prices are higher.
Supplementation of weaners	Ensure that weaner lambs do not undergo nutritional stress during periods of low pasture quality and availability.	Silage can safely be fed to weaner lambs without any nutritional problems. Ideally should have access to silage while still on ewes to increase acceptance.
Weaner management	Pre-conditioning or training of weaners to reduce shy-feeder problems when full feeding. Reduce grass seed contamination (skin damage and wool contamination). Provide low worm burden pasture (regrowth) for grazing as part of a management strategy for internal parasites.	Shy feeder problems and reduced animal production can be minimised by 'training' animals before full feeding. Regrowth following a silage cut can provide a 'clean' (reduced grass seed, low worm burden) grazing area in late spring/early summer, for weaners or other classes of sheep.
Cull sheep	Increase liveweight and condition.	Strategic short-term supplementation of cull ewes and wethers before sale. High-quality silages will maximise liveweight gain and profitability.
All classes	Drought feeding for maintenance or production, depending on class of sheep.	Excellent drought feed for all classes of sheep. Producing high-quality silage reduces silage-making, storage and feedout costs per unit of conserved energy (ME), and allows it to be used for production feeding if required. This provides management flexibility.

Section 15.1

Sheep production potential from silage

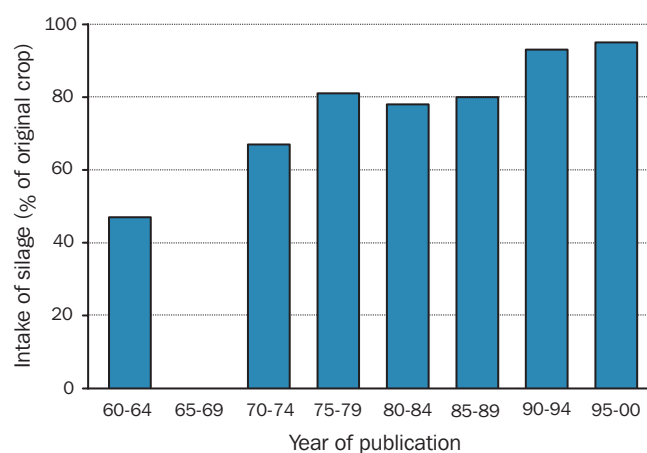
Sheep liveweight gains observed on pure silage diets are in line with expectations for the level of ME intake (MJ/day) (see Table 15.2). The potential production from silage diets can be limited by the ME content, fermentation quality and, to a lesser extent, the crude protein content of the silage. In practice, the production from silage will often be less than expected unless the fermentation quality is excellent (see Section 15.2.2). Fermentation quality has an effect on silage DM intake and unless fermentation quality is excellent, intake will be less than achieved for other non-silage forages of similar ME content.

In a well-preserved silage where there is limited protein degradation (ammonia-N <5% total N), intake (and animal production) will be high and approach that achieved on the parent forage.

As developments in silage-making technology have improved silage fermentation quality and silage intake has approached the level achieved on the parent forage (see Figure 15.1). The improvement in equipment and technology to achieve a successful, rapid wilt has been a major advance.

Figure 15.1

Change over time (1960-2000) in the relative intake of silage compared with the original crop in research studies.



Source: Charmley (2001)

Table 15.2

Production from crossbred lambs fed silage.

	Silage type					
	Subclover ¹	Medics ¹	Other clovers ¹	Seradella ¹	Lucerne ²	Maize ^{1*}
Digestibility (%)	69.2 (59.3-77.4)	71.7 (66.5-75.7)	66.2 (56.2-80.1)	65.9 (53.5-73.3)	71.9 (67.9-76.4)	67.3 (66.1-69.4)
Ammonia-N (% total N)	7.2 (5.7-10.5)	8.9 (6.5-11.4)	7.6 (6.5-9.0)	10.4 (8.6-12.6)	11.6 (9.2-14.2)	10.1 (8.5-11.2)
DM intake (% of liveweight)	3.5 (2.6-4.9)	3.9 (3.3-5.2)	3.7 (2.8-4.6)	3.9 (2.7-4.8)	4.0 (3.9-4.1)	3.0 (2.9-3.3)
Liveweight gain (g/day)	108 (14-247)	89 (8-140)	103 (54-171)	102 (55-145)	143 (127-159)	122 (112-134)

1. DM digestibility determined in sheep.

2. OM digestibility determined in the laboratory.

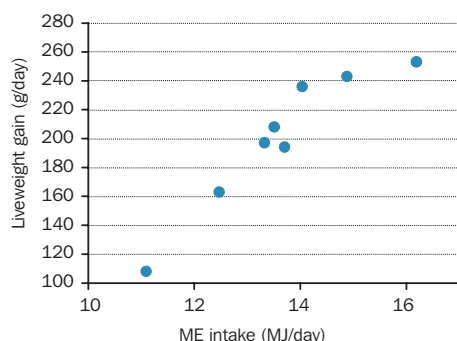
Ranges are in brackets.

* Maize silages were fed with a urea (2% silage DM) and mineral supplement.

Source: Mulholland and Scott (1992); Piltz (1993)

Figure 15.2

Relationship between estimated* ME intake and liveweight gain of crossbred (Border Leicester x Merino) lambs fed mixed subclover silage and grain diets.

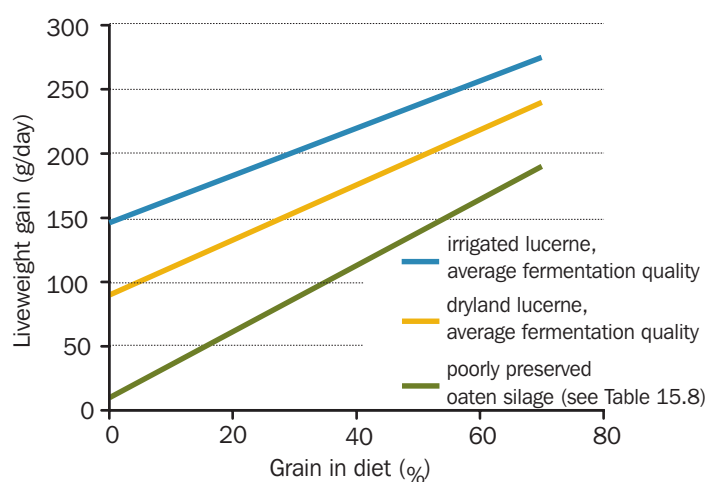


Source: Adapted from Graham et al. (1992)

* Silage ME recalculated using equation 6 (in Chapter 12, Section 12.4.2).

Figure 15.3

Liveweight gain of crossbred (Border Leicester x Merino) lambs fed different silages with varying proportions of grain.



Source: Adapted from Holst et al. (1999)

15.1.1

Using grain supplements with silage

Grain will supply readily fermentable (available) energy to the rumen, which will increase utilisation of the degraded nitrogen by the rumen micro-organisms, resulting in increased intake and production. Evidence for this comes from a study conducted at Wagga Wagga, NSW (see Table 15.3). Crossbred lambs fed a high-quality subclover silage gained 108 g/day on the silage-only diet. There were significant increases in total DM and ME intake and liveweight gain, even when small quantities of barley grain were added to the diet. The barley provided a source of readily fermentable energy, which increased the utilisation of the nitrogen fraction of the silage in the rumen.

Liveweight gain was directly related to ME intake by the lambs in this study (see Figure 15.2). More information on the issue of feeding grain to sheep in silage diets is given in Section 15.3.

Table 15.3

Production from lambs fed subclover silage and grain diets.

	Grain type							
	Nil	Barley				Barley/lupin		
Grain in the diet (%)	0	25	50	75	25 (79:21)*	50 (79:21)	75 (79:21)	75 (66:34)
Diet crude protein (%DM)	17.9	16.8	15.6	14.5	17.9	17.9	17.9	20.0
Diet ME (MJ/kg DM)	10.2	10.8	11.3	11.9	10.8	11.4	12.0	12.1
Total intake (kg DM/day)	1.09	1.16	1.18	1.14	1.27	1.42	1.24	1.16
Liveweight gain (g/day)	108	163	197	208	194	253	243	236
Feed efficiency								
(kg feed DM/kg liveweight gain)	10.11	7.27	6.09	5.99	6.72	5.64	5.16	4.95
(kg liveweight gain/t feed DM)	99	138	164	167	149	177	194	202

* Ratio of barley:lupin shown in brackets.

Lambs – initially 31kg liveweight.

Source: Graham et al. (1992)

Replacing part of the barley with lupins to maintain diet crude protein content at the same level as the silage, further increased intake and lamb liveweight gain. However, based on feeding standards, the crude protein content of all the diets should have been more than sufficient to meet the liveweight gain potential and should not have limited production. This suggests that the lambs were responsive to protein N that was not supplied by the silage.

Because adding grain to silage-based diets will increase intake and liveweight gain of lambs, extra grain can be used to compensate, to some extent, when feeding lower-quality silages. Figure 15.3 shows the range of expected growth rates for a range of diets for finishing crossbred lambs in a feedlot.

15.1.2

The role for protein supplements

Protein supplements can be used to supply bypass (or undegradable) protein or a source of rumen degradable protein (RDP). The crude protein content of the silage and the extent to which this has been degraded during the silage fermentation will determine the response by animals on silage diets to protein supplements. Chapter 12, Section 12.4.4, discusses in more detail how fermentation quality and degradation of the protein fraction in silage may effect utilisation of silage nitrogen and silage DM intake.

Table 15.4 highlights the potential impact of supplementation of silage with protein meal on intake and liveweight gain. In this UK study, ryegrass silage was fed alone or with rapeseed meal that was either untreated or treated with formaldehyde. Formaldehyde treatment reduces degradation of the protein in the rumen – supplying more bypass protein. The ryegrass was ensiled with formic acid to ensure good preservation.

Table 15.4

	Rapeseed meal	
Proportion in diet (%)	0	12
Silage DM intake (g/day)	627	688
Total DM intake (g/day)	677	860
(% liveweight)	1.7	2.0
Final liveweight (kg)	40.4	45.1
Liveweight gain (g/day)	30	135
Carcase weight (kg)	16.9	19.0
N retained (g/day)	3.6	8.3
(% total intake)	24.7	34.9

*Effect of supplementation with rapeseed meal on production from lambs fed ryegrass silage.**

* Composition of the silage: 25.6% DM; pH 3.8; 11.3% crude protein (DM basis); 3.6% Ammonia-N (% total N); estimated ME 10.0 MJ/kg DM. Ryegrass was wilted for 24 hours and ensiled with 2.5 L/t formic acid.

Lambs – initially 39 kg.

Source: Adapted from Yilala and Bryant (1985)

Although well preserved, as indicated by the low pH and ammonia-N content, supplementation with rapeseed meal increased total and silage DM intake, which was reflected in higher liveweight gains. There was no difference in the intake and liveweight gain of lambs fed treated and untreated rapeseed meal and the results were averaged. Nitrogen utilisation was higher for supplemented lambs, as indicated by the percentage of total N retained. In this study, the response from rapeseed meal supplementation was probably due to an improved amino acid supply in the small intestine, either directly due to increased uptake of bypass protein or indirectly due to increased supply of protein N for the rumen micro-organisms.

The crude protein content of the silage in this study was marginal (11.3% DM basis) and this would have partly accounted for the magnitude of the response to supplementation with protein meal.

However, in the study conducted at Wagga Wagga (see Table 15.3) where the crude protein content of the silage was high (17.9% DM basis) supplementation with additional protein (barley:lupin mix) also increased intake and liveweight gain compared to supplementation with barley alone. These results suggest that there may be a production response to additional protein, even when sheep are fed well-preserved, high-quality silages.

Further studies are needed to quantify the benefits of protein supplementation for lambs fed high-quality wilted silages, including legume silages. These studies should also investigate if inoculants reduce protein degradation during ensiling and what consequences this may have on the need for protein supplements (see Section 15.2.4).

15.1.3

Legume silages

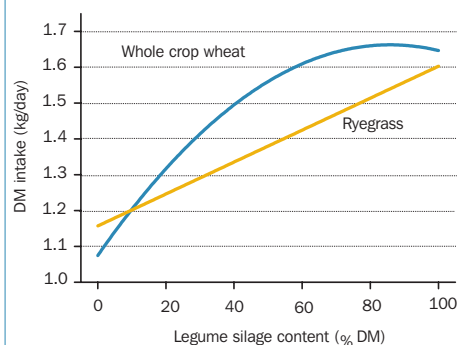
Legumes are digested more quickly than grasses and, as a result, DM intakes are usually higher for legumes than for grasses of the same digestibility. Similarly, well-preserved silages produced from legume crops and pastures will often support higher intakes and animal production than grass or cereal silages of similar digestibility.

In a UK study, ewes consumed more when fed legume silages compared to ryegrass or whole crop wheat silages. The amount consumed by ewes fed a mixture of legume and grass/cereal silages was intermediate and depended on the proportion of the two silages in the diet (see Figure 15.4). With the exception of the whole crop wheat silage (10% crude protein DM basis) all the other silages and mixtures had crude protein contents >13.5%, which should have been non-limiting for these animals.

Another advantage of legume parent forages is their potentially high crude protein content, which is also usually higher for legume silages than their non-legume counterparts.

Figure 15.4

Effect of legume silage content in the diet on DM intake by ewes.



Mean of 2 treatments. Diets consisted of a mix of either lucerne or red clover silage plus either ryegrass or whole crop wheat silage.

Source: Adapted from Fraser et al. (2002)

Section 15.2

Factors affecting sheep production from silage

The potential production from sheep fed silage is influenced by a number of factors:

- ▶ silage digestibility, ME content and silage fermentation quality are the most important;
- ▶ silage DM content is also important and can affect silage intake directly or indirectly, through its influence on silage fermentation quality;
- ▶ silage additives can improve sheep production through their effect on silage fermentation quality and reduction in protein degradation during ensiling; and
- ▶ management factors such as chop length and feedout method influence silage intake and therefore production.

Each of these issues is discussed in the following sections.

15.2.1

Silage digestibility or ME content

Silage digestibility or ME content, along with fermentation quality (see Section 15.2.2), is one of the key factors affecting potential production from sheep fed silage. Silage digestibility or ME content is dependent on:

- ▶ the type of crop or pasture ensiled;
- ▶ growth stage (maturity) at which the crop or pasture is harvested; and
- ▶ losses in energy that occur during wilting, harvesting and ensiling.

Digestibility is highest when plants are at a vegetative stage of growth, and declines as plants enter the reproductive stage (see Chapter 4, Figure 4.3). Yield often continues to increase as plants mature and it is tempting to delay harvest to increase the quantity of silage conserved. However, the increase in yield is often not sufficient to overcome the decline in digestibility, and potential for animal production per hectare of harvested forage declines. Chapters 4 and 5 provide details on the

Plate 15.2

Legume/grass pastures are ideal for silage. The legume component increases protein content and will sustain higher intake and animal production at a given digestibility than pure grass silage. The grass component increases yield potential and the WSC content.

Photograph: F. Mickan



quality and yield of various species at different stages of growth and discuss the issue of growth stage at harvest and the compromise between quality and yield.

The effect of growth stage on yield and silage quality was demonstrated by the results of an Irish study where lambs were fed perennial ryegrass silage cut at three growth stages (see Table 15.5). Although yield increased as the pasture matured, quality declined. Delaying silage harvest until the flowering stage doubled the yield but resulted in a decline in digestibility and crude protein compared to leafy (vegetative) ryegrass.

The impact of growth stage on silage quality is highlighted by the production from lambs fed the silage from the three growth stages, either with or without a barley supplement. Intakes were low for all the silages, reflected in the liveweight gains, and decline with the silage digestibility.

The silages produced were all well preserved and the low intake may have

been due to the low crude protein content of the silages, particularly at the later two harvests. Only on the earliest cut silage-only diet did lambs actually gain weight.

Lambs fed silages produced at either of the later two harvests lost weight.

Supplementing with barley improved production from all silages, with all lambs receiving the barley supplement gaining weight, although there were still differences in lamb liveweight gain between silages.

Maximum carcass weight gain *per hectare* in this study was for lambs fed barley plus the silage harvested at the intermediate growth stage. This is close to the 10-20% ear emergence growth stage recommended for harvesting perennial ryegrass silage – a compromise between yield and quality.

Whole crop cereals, cereal/legume mixtures, maize and grain sorghum can maintain digestibility during the early stages of grain filling because increasing grain content can offset the decline in leaf and stem digestibility (see Chapter 5).

Table 15.5

Effects of growth stage at harvest on the quality of perennial ryegrass silage and subsequent lamb production.

	Leafy		Ear emergence		Flowering	
Forage characteristics:						
Length of closure (weeks)	6		8		10	
Yield (t DM/ha)	3.9		5.7		8.0	
DM content (%)	18.5		19.8		19.5	
Crude protein (%DM)	12.7		9.7		8.3	
DM digestibility (%)	74.9		71.6		65.7	
Silage characteristics:						
pH	3.7		3.7		3.7	
Volatile N (% of total N)	5.9		4.8		7.9	
Crude protein (%DM)	12.4		8.9		8.9	
Estimated ME (MJ/kg DM)	11.2		10.0		9.8	
Animal production:						
	Silage	+ Barley	Silage	+ Barley	Silage	+ Barley
Silage intake (g DM /day)	787	737	559	587	437	468
Barley intake (g DM/day)	0	256	0	256	0	256
Liveweight gain (g/day)	12	92	-17	55	-56	28
Carcass weight gain (g/day)	21	68	-13	44	-40	19
Carcass gain/ha cut (kg)	–	288	–	342	–	260

Ryegrass ensiled with 2.5 L formic acid/t fresh forage. Barley supplement fed at 300 g/day. Lambs initially 38.5 kg liveweight. Carcass weight gain per hectare assumes a total of 20% losses ensiling between mowing and feedout.

Source: Fitzgerald (1987)

Table 15.6

	Head emergence	Milk	Dough
DM content (%)	22.2	27.3	31.7
pH	4.1	3.9	3.9
Ammonia-N (% of total N)	13.3	12.4	10.0
Crude protein (% DM)	10.6	9.7	9.8
DM digestibility (%)	69.0	66.3	66.6
Estimated ME (MJ/kg DM)	10.7	10.8	10.3
Liveweight* (kg)	46.3	45.8	47.4
Intake (g DM/day)	880	1,085	1,146
DM intake (% liveweight)	1.9	2.4	2.4
Estimated ME intake (MJ/day)	9.4	11.7	11.8
N retained (% N intake)	11.5	13.3	20.6
N retained (g/day)	2.0	1.8	3.0

* Average liveweight over the 28-day feeding period.

Effect of growth stage at harvest of whole crop barley silage on digestibility and N retention when fed to ram lambs.

Source: Adapted from Borowiec et al. (1998)

This was highlighted by the results of a Polish study, which compared whole crop barley silage, direct-harvested at either head emergence, milk or dough grain stage and fed to growing ram lambs (see Table 15.6). Fermentation quality of the three silages was moderate, with acceptable pH values, but the ammonia-N contents were marginally higher than acceptable for well-preserved silage. Digestibility and estimated ME content declined only slightly as the barley matured.

Intake by the lambs increased with maturity of the barley at harvest, which was probably mainly a response to increasing DM content. Ammonia-N content declined slightly with crop maturity, and as DM content increased, and may also have contributed to the increase in intake. As a result, total energy (ME) intake was the highest when lambs were fed silage produced at either the milk or dough stage of grain development. Nitrogen retention by the lambs, which is closely related to liveweight gain, was highest for barley harvested at the dough stage.

15.2.2

Silage fermentation quality

Silage fermentation quality will depend on the characteristics of the forage ensiled (DM and WSC content and buffering capacity) and the dominant bacteria during the fermentation phase (see Chapter 2, Sections 2.1, 2.2 and 2.3). Well-preserved silage will have lactic acid as the main product of fermentation, a pH value appropriate for the DM content and <10% of the total N will be in the form of ammonia (see Chapter 12, Section 12.4.5). Conversely, poorly preserved silages will contain significant amounts of other acids besides lactic acid, have a high pH for its DM content and the protein fraction will be highly degraded, (ammonia-N content >15%).

Poorly preserved silages are unpalatable to livestock, and even when the ME is high, animal production is low because of depressed intake. Ensuring a good fermentation will maximise silage DM intake and potential animal production.

As well as the palatability effect, the lower intake observed on poorly fermented silages appears to be associated with inefficient utilisation of the nitrogen

fraction of the silage. Protein is partially degraded during the fermentation and is present in the form of free amino acids, ammonia-N and other non-protein N compounds, which are rapidly degraded in the rumen (see Chapter 2, Section 2.2, and Chapter 12, Section 12.4.5). Any nitrogen not used by the rumen micro-organisms is lost as ammonia (see Chapter 12, Section 12.4.4).

The inefficient use of silage protein by sheep is not well understood but may act in the following ways:

- ▶ The amino acid supply to the intestine is inadequate and operates as a negative feedback mechanism, depressing intake.
- ▶ The rumen micro-organisms may have a requirement for pre-formed amino acids, not supplied by the silage.
- ▶ The level of ammonia in the rumen rises after feeding. There is some evidence that where the nitrogen fraction of a silage is highly degraded during ensiling, the rise in the ammonia level can be quite dramatic, and may directly reduce silage DM intake.

Improved fermentation quality was shown to increase silage intake by sheep in four French studies (see Table 15.7). The time spent eating the relatively poorly preserved silage was the same but silage intake was lower.

The impact of silage fermentation can also be seen in a study at Cowra, NSW, where poorly preserved oaten silage was fed to crossbred lambs (see Table 15.8). The oats was wilted for 48 hours prior to ensiling but only reached 29.4% DM content. The silage fermentation quality was poor – high pH and high ammonia-N levels.

In this case, the estimated ME and crude protein content of the oaten silage was at least as good as the subclover silage (see Table 15.3) which had supported lamb liveweight gains of 108 g/day. If the intake of the oaten silage had been higher, similar to what might be expected for other feed types of similar quality, gains of 135 to 150 g/day would not be unrealistic. However, given the poor fermentation quality, it was not surprising that the silage DM intake was low and that liveweight gain was very low.

Table 15.7

Effect of fermentation quality on silage intake by sheep.

	Poorly preserved silage	Well-preserved silage*
Silage composition:		
DM content (%)	19.2	21.0
pH	4.5	3.9
Ammonia-N (% total N)	11.2	5.7
Lactic acid (% DM)	4.8	6.0
Acetic acid (% DM)	7.1	2.0
Propionic acid (% DM)	0.3	0.02
Butyric acid (% DM)	0	0
Alcohols (% DM)	3.3	0.8
Relative animal response:		
DM intake (%)	100	115
Time spent eating (%)	100	98

Data from four experiments with 1 x lucerne, 2 x Italian ryegrass and 1 x fescue silage.

* Well-preserved silages produced using formic acid additive.

Source: Demarquilly and Dulphy (1977)

Table 15.8

Liveweight gain of crossbred lambs (Dorset x Border Leicester x Merino) fed poorly preserved oaten silage.

Silage composition:	
DM content (%)	29.4
pH	4.8
Crude protein (% DM)	14.8
Ammonia-N (% total N)	19.9
OM digestibility (%)	74
Estimated ME (MJ/kg DM)	10.7
Lamb production:	
DM intake (% liveweight)	2.3
Liveweight gain (g/day)	6

Source: Holst et al. (unpublished data)

15.2.3

Wilting

Under Australian conditions, wilting is the most commonly used, effective strategy to ensure a good silage preservation. How to wilt and the impact of wilting on fermentation quality are discussed in more detail in Chapters 2 and 6.

Effective wilting ensures reduced silage effluent losses, improved silage fermentation quality and animal production (see Chapter 2, Section 2.1.1). The improvement in animal production is in response to increased silage palatability and intake, as a result of increased DM content and improved fermentation quality (see Chapter 6, Section 6.5.2).

Most studies looking at the effect of wilting on intake and production have been with cattle and benefits of wilting on animal production were not always observed. The possible reasons for this are discussed in more detail in Chapter 14, Section 14.2.3. Recent studies suggest that increased intake and animal production will be achieved when wilting to the target DM content is achieved rapidly (<24-48 hours) and final DM content is in the 35-50% range, depending on the crop or pasture type and storage system.

In a Scandinavian study, round bale silage was produced from grass that was either

unwilted or wilted for 24 hours prior to ensiling. As Table 15.9 shows, wilting improved silage quality and increased intake, liveweight and carcass weight of lambs.

Silage is often provided as a supplement to grazing livestock during periods of low pasture quality and/or availability. In one New Zealand study, ewes losing weight on pasture during February/March were supplemented with ryegrass-dominant pasture silage (see Table 15.10). Supplementation increased total daily intake and ewes gained weight. Ewes supplemented with wilted pasture silage consumed more silage and had higher total intakes and liveweight gains compared to ewes supplemented with unwilted silage. (More results from this study are presented in Table 15.16.)

Table 15.9

*Effect of wilting of pasture silage on silage composition and lamb production.**

	Unwilted	Wilted
Silage composition:		
DM content (%)	24.6	41.6
pH	5.44	5.9
Ammonia-N (% of total N)	10.2	5.1
WSC (% DM)	2.1	10.1
Lamb production:		
Silage DM intake (g/day)	780	920
Liveweight gain (g/day)	114	155
Carcass weight (kg)	12.3	13.4
Dressing percentage (%)	40.2	40.8

* Five-month-old lambs. Minerals were available at all times.

Source: Gudmundsson and Bornsteinsson (1999)

Table 15.10

Effect of supplementation with ryegrass dominant pasture silage on intake and production from ewes grazing low-quality pasture.*

	Grazed pasture alone	Pasture plus direct cut silage (flail)	Pasture plus wilted silage (flail)	Pasture plus wilted silage (chopped)
Silage DM content (%)	–	16	32	32
Pasture DM available (kg/ewe/day)	1.7	1.6	1.7	1.5
DM intakes (kg/day):				
Grass	1.24	1.05	1.02	0.84
Silage	0.0	0.38	0.71	0.99
Total	1.24	1.43	1.73	1.83
Pasture utilised (%)	77	72	65	59
Liveweight change (g/day)	-15	11	60	83

Silages had a mean *in vivo* DM digestibility of 66% and crude protein content of 15% (DM basis).

* The perennial ryegrass was harvested for silage just prior to head emergence.

Source: Rattray (1977)

15.2.4

Silage additives

The main reasons for using additives:

- ▶ To improve silage fermentation quality where there is a risk of poor preservation. This has traditionally been the main role for additives, such as formic acid, in Europe (see Chapter 7, Tables 7.11, 7.16 and 7.22).
- ▶ To reduce aerobic spoilage during feedout (see Chapter 7, Section 7.7). Additives are likely to be important for unstable silages, such as maize, and during hot weather when silages become less aerobically stable. Aerobic instability reduces silage quality through loss of ME and changes to the protein fraction. Palatability is also reduced.
- ▶ To improve animal production from otherwise well-preserved silages through the use of bacterial inoculants.

Inoculants are the additives that are most likely to be important for the Australian sheep industries and discussion is confined to them in this section. (For more detailed information on the various additive types and their mode of action, see Chapter 7.)

Many earlier studies conducted to evaluate inoculated silages gave variable results when treated silages were fed to animals. In some cases there was no improvement in animal production, even where there was a slight improvement in silage fermentation quality. In other studies animal production increased even where there did not appear to be any improvement in silage fermentation quality and digestibility (see Chapter 7, Section 7.4.3).

Recent studies indicate that the strain of bacteria used as an inoculant may be important in achieving animal responses (strain is the term for a particular selection from within a species of bacteria). Further studies are required to confirm this and identify appropriate strains of bacteria for use under Australian conditions.

Inoculants are most likely to provide an economic benefit when silage is the major component of the production ration fed to responsive animals, e.g. young, growing sheep.

In a UK study, lambs were fed ryegrass that had been ensiled either with or without a commercial bacterial inoculant. As indicated in Table 15.11, the silages were similar and well preserved. Lambs consumed more of the inoculated silage and retained more of the nitrogen. Nitrogen retention indicates better utilisation of the nitrogen fraction and more carcass growth for lambs fed inoculated silage.

The inoculant in the above study also contained a mix of enzymes. Enzymes are included in a number of commercial additives. Chapter 7, Section 7.4.2, provides more detail on the use of enzymes during ensiling, and provides some information on the possible impact on sheep production in Table 7.8.

Table 15.11

Effect of an inoculant on production from lambs fed ryegrass silage.

	Untreated	+ Inoculant
Silage composition:		
DM content (%)	20.3	20.1
pH	4.31	4.39
Crude protein (% DM)	22.2	20.8
Ammonia-N (% total N)	5.8	3.2
Estimated ME (MJ/kg DM)	12.0	11.6
Lactic acid (%DM)	10.9	6.7
Sheep production:		
DM intake (g/day)	785	930
N intake (g/day)	25.1	29.5
Retained N (g/day)	9.4	12.7
(% N intake)	37.3	42.9

Eight-month wether lambs (32-40 kg). Inoculant contained LAB and a mixture of enzymes.

Source: Jones and Woolford (1996)

The use of a *Lactobacillus buchneri* inoculant in a United States study shown in Table 15.12, improved aerobic stability of maize silage upon exposure to air compared to maize ensiled without an inoculant. Although DM intake was only marginally higher for the inoculated silage there was a 69% increase in liveweight gain when fed to lambs. The reason for this large improvement in liveweight gain is not clearly understood.

The silages were similarly well preserved, as indicated by pH and ammonia-N levels. Any uneaten silage was collected at the end of each day (24-hour period) and assessed. Although the number of yeasts and moulds had increased for both silages, the counts were higher for the silage without additive. (Yeasts are the primary cause of instability upon exposure to air – see Chapter 2, Section 2.3.4.)

Deterioration of the silage during the day, as indicated by a rise in pH, was also more extensive for the silage without additive.

A similar response to inoculant-treated ryegrass silage is presented in Chapter 7, Table 7.11, but further research is needed to determine the role for inoculants under Australian conditions and to identify species and strains that could improve silage preservation and recovery, aerobic stability and subsequent sheep production. However, these results suggest there is potential for significant economic benefits from the use of inoculants.

15.2.5

Chop length and silage form

Sheep are very sensitive to chop length and the impact of reducing chop length is usually greater for sheep than for cattle.

Much of the information on the effect of chop length on sheep production relates to forage-harvested (chopped) grass, mainly perennial ryegrass, silages. Most were either unwilted or only lightly wilted and many were ensiled using formic acid additive. In most of these studies, sheep ate more and production improved with shorter chop length silages. However, there is some evidence from Australian studies, that intake may not be restricted when sheep are fed baled, wilted legume silages.

Further research is required to investigate the impact of chopping on naturally short, fine-stemmed plant species, such as subclover.

Table 15.12

	Untreated	+ Additive
Silage composition:		
DM content(%)	30.2	32.5
pH	3.69	3.64
Ammonia-N (% total N)	7.46	7.54
Yeasts (cfu/g fresh silage)	1.2×10^5	9.1×10^2
Lactic acid (% DM)	6.6	6.8
Acetic acid (% DM)	3.2	5.0
Aerobic stability* (hrs)	18.5	43.4
Composition of uneaten silage (after 24 hrs):		
pH	4.87	4.32
Yeasts (cfu/g fresh silage)	7.2×10^8	9.3×10^7
Animal production:		
DM intake (g/day)	903	935
Liveweight gain (g/day)	83	140

Dorset ram lambs (initially 35.7 kg) were fed 15% soybean meal, 85% maize silage + 5 g mineral supplement.

* Aerobic stability was determined as the time taken for a sample of the silage to reach a temperature 2°C above the baseline silage temperature.

Effect of application of an inoculant (Lactobacillus buchneri 40788) to maize at ensiling on aerobic stability of the silage and liveweight gain when fed to lambs.

Source: Ranjit et al. (2002)

Another advantage of short chopping is improved fermentation quality, as a result of better compaction and more rapid release of WSCs for fermentation, (see Chapter 2, Section 2.4). The positive effect of chop length on intake is likely to be a combination of chop length and fermentation quality.

Several French studies investigated the effect of chop length without any fermentation-quality effect. Silages produced using a flail harvester were finely chopped just prior to feeding to sheep. Intake was compared with the same silage fed to sheep without chopping. The summary of results in Table 15.13 shows that chopping significantly increased intake of both grass and lucerne silages.

In the Irish study summarised in Table 15.14, perennial ryegrass silages were produced without chopping, or using either a flail or precision chop forage harvester. Each forage-harvested silage was produced at two chop lengths. All were well preserved and had high digestibility (high ME content). When the silage was fed to lambs, DM and ME intake increased as chop length decreased. This was reflected in improved lamb liveweight and carcass weight gain with decreasing chop length.

It is important to note that the intake of silage produced without chopping was low and slightly below that required for maintenance whereas the shorter of the two precision chop silages supported liveweight gains of 151 g/day and carcass weight gains of 81 g/day. Precision chop silages also had higher intakes and supported higher liveweight and carcass weight gains at a similar chop length when compared to the flail harvested silages.

The results in Tables 15.10 and 15.16 also show the advantage of fine chopping.

Table 15.13

Influence of chopping of flail harvested silage just before feeding on DM intake.

Source: Adapted from Demarquilly and Dulphy (1977)

Silage type	Number of comparisons	Relative DM intake (%)	
		Without chopping	With chopping
Grass	2	100	150
Lucerne	4	100	129

Table 15.14

Effects of chop length of ryegrass silage on production from lambs.

	Unchopped*	Single chop flail	Double chop flail	Precision chop	
				Long	Medium
Average chop length (mm)	324	130	91	118	68
Particles <50 mm (%)	0.6	22.0	38.9	32.1	51.3
DM content (%)	17.7	19.8	17.7	21.6	21.3
pH	3.7	3.7	3.8	3.8	3.7
DM digestibility (%)	79.9	74.9	76.0	81.0	77.3
ME (MJ/kg DM)	11.2	11.0	11.1	11.3	11.3
Crude protein (% DM)	14.2	15.5	17.4	15.4	16.7
Intake (g DM/day)	572	661	750	893	1,129
(% liveweight)	1.6	1.7	1.9	2.2	2.6
ME intake (MJ/day)	6.4	7.3	8.3	10.1	12.8
Liveweight gain (g/day)	-3	40	53	85	151
Carcass weight gain (g/day)	-11	2	27	47	81

* Mown and then harvested using a forage wagon with the knives removed. Ensiled with 3 L/t formic acid.

Lambs initially 37.4 kg liveweight.

Source: Fitzgerald (1996)

Research at Cowra, NSW, compared various silage storage and feedout systems on DM intake of wilted lucerne silage by crossbred lambs. Table 15.15 shows the silage storage systems and animal production results from this study. The baled silages were fed both whole or loose (round bale) or in biscuits (square bales). Breaking up bales to feed the loose silage/ biscuits had no impact on lamb production and results are not included in the Table.

The silage fermentation quality ranged from good to only fair for the silages, as indicated by the ammonia-N content. The more extensive fermentation that the precision chop silage had undergone is reflected in its higher ammonia-N (% of total N) content. This is consistent with the effect of chopping before ensiling (see Chapter 2, Section 2.4) and the lower DM content of the precision chopped silage.

There were no differences between storage and feedout system on lamb liveweight gain. This is inconsistent with the previous overseas studies conducted on chop length and intake/liveweight gain. Possible explanations that may have contributed to this outcome are:

- ▶ Differences in fermentation between baled and precision chop silages. The ammonia-N content of the precision chopped silage would have reduced silage DM intake and liveweight.
- ▶ To maximise possible intake for each silage, the lambs were fed more silage than they could consume and access to the bale silages was unrestricted.
- ▶ Lambs may have been able to effectively 'graze' the bales, allowing them to select the higher quality leaf fraction and also reduce the particle size of what they consumed.
- ▶ These results were with wilted lucerne silages, whereas most overseas studies have been conducted with grasses (in particular ryegrass).

In the light of the difference between this study and overseas results, further Australian studies are required to investigate sheep production from various forms of silage fed under a range of practical conditions. Studies should also include a range of forages to determine whether the impact of storage method and chop length is less for legumes, such as subclover, than for cereals or grass-dominant pasture.

Table 15.15

	Conventional round baler Not chopped at feeding	Chopping round baler	Large square baler	Precision chop	
Average particle length (mm)	420	15	90	420	15
Silage composition:					
DM content (%)	50.7	50.7	42.6	45.9	41.6
pH	5.3	5.3	5.3	5.4	4.9
Crude protein (% DM)	21.4	21.4	25.5	25.7	25.3
Ammonia-N (% total N)	9.2	9.2	12.0	10.8	14.2
ME (MJ/kg DM)	9.9	9.9	9.9	9.9	10.5
Animal production:					
DM intake (kg/day)	1.55	1.54	1.53	1.53	1.46
Liveweight gain (g/day)	143	159	140	151	127
Feed efficiency (kg liveweight gain/t silage DM)	92.8	102.9	95.1	96.7	83.6
Carcase weight (kg)	19.5	19.9	19.6	19.7	19.9
GR** (mm)	12	12	12	12	13

* Chopped silages were fed loose, in troughs. Bales were fed whole.

** GR is tissue depth over the 12th rib 110 mm from the midline.

Effect of silage storage and feedout system on DM intake of lucerne silage by crossbred (Dorset x Border Leicester x Merino) lambs and subsequent animal production.*

Source: Holst et al. (unpublished data)

15.2.6

Feedout system

The key objectives of a feedout system should be minimising wastage and ensuring that accessibility to the silage by the animal is not restricted.

There are a number of feedout systems available for delivering silage or silage-based diets to sheep. The system chosen will depend on the whether the silage is chopped or baled, the level of production required and what equipment is available for feedout. Chapter 10, Section 10.3.1, discusses the options in more detail.

Accessibility is covered in greater detail in Chapter 10, Section 10.3.2, and is influenced by:

- ▶ the physical access to the feed, the available feeding space or access time per animal during the day;
- ▶ the physical form or the way in which the silage is presented to the animal (e.g. loose, in blocks, as a whole bale, or self-fed from a bunker face); and
- ▶ the chop length.

Restricting feeding time will reduce intake, as will limiting the available trough space. Accessibility (available space) to baled silage, fed whole, is likely to be an important limitation. A rule of thumb when large amounts of silage are fed is to provide access for 25% of the sheep to feed at any one time.

If a silage supplement is only a small part of the diet, and available space or time limits access, dominant animals may consume most of the silage. Some animals may consume little or no silage. Providing more silage at less frequent intervals (e.g. every second day) will increase access and supplement intake for less-dominant sheep.

The effect of silage systems on sheep production

In the absence of more information on the effect of the various silage systems on sheep production, producers need to be aware of the following issues:

- ▶ The chosen feedout system should minimise wastage from trampling and fouling.
- ▶ Accessibility will depend on:
 - the feedout system (e.g. bale vs troughs);
 - the amount of silage fed (supplement or total ration);
 - how often feeding occurs; and
 - the time available for feeding.

Plate 15.3

Good feedout management to minimise wastage is critical to the profitability of silage feeding. The system of whole bales fed on the ground has a high wastage component and accessibility may be limited. If lambs have difficulty accessing the bales DM intake will be affected, particularly for long particle length silages, e.g. cereals and grasses. Photograph: K. Kerr



Section 15.3

Finishing lambs in feedlots with silage-based diets

Producers use feedlots to opportunistically finish lambs or as a permanent operation. Opportunity feedlotting usually occurs when pasture quality and/or quantity means lambs cannot be finished on pasture or when lamb prices are high relative to feed costs. Small paddocks with a minimal amount of available pasture are usually used. Professional feedlotters are more likely to use purpose-built yards, feeding several groups at any one time to ensure continuity of supply.

Silage-based rations can be fed to lambs to finish animals to market specifications.

Minimising feed costs is essential to ensuring a profitable lamb feedlot.

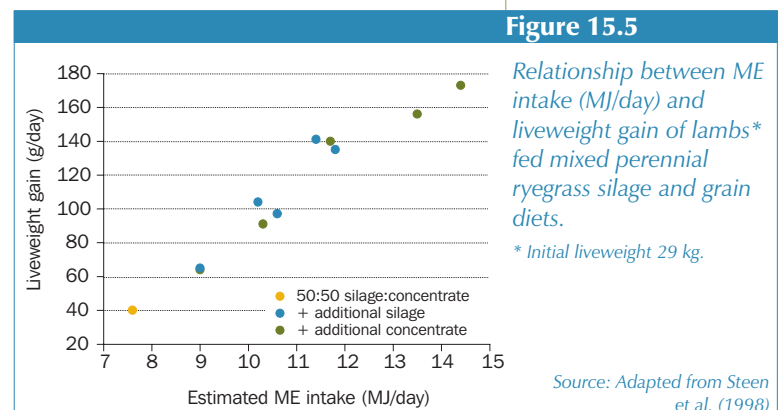
The profit per lamb will depend on the ability to meet the target market (size of the lamb and fat cover), skin value, liveweight gain, feed prices, labour requirements, the cost for feeding, and the difference in starting and finishing value of the lamb. Because the margin for feedlotting lambs is often small, it is recommended that a firm selling price (preferably a written contract) is known before feeding commences.

When targeting a particular market, such as 'out-of-season lamb', it is sometimes more profitable to have slower liveweight gains and reach market specifications when lamb supply is low and prices are high. Silage-based diets are suited for this purpose. However, before deciding to delay turnoff, producers should evaluate the higher returns against any extra costs incurred.

Any silage-based diet designed to finish lambs will probably contain a proportion of grain, and possibly a source of additional protein. Section 15.1 highlighted the often lower-than-expected lamb liveweight gains observed on silage-only diets, and the production responses that have been observed in an Australian study with the inclusion of grain in the diet (see Table 15.3). As was shown in that study, the increased liveweight gain was directly related to increased ME intake (Figure 15.2).

These results were confirmed in an Irish study, where lambs were fed mixed diets of perennial ryegrass silage and concentrate (see Figure 15.5). Lambs on the control diet were each fed 600 g/day of a 50:50 mix of silage and concentrate. Additional energy was then supplied to other lambs with either additional concentrate or silage. The concentrate was composed of 80% barley, 15% protein meal, plus minerals, vitamins and molasses. The barley supplied a source of readily fermentable energy and the protein meal was a source of protein N. Between 32 and 74% of the daily DM intake of the lambs was supplied by concentrate. The results clearly showed that increasing dietary energy supply (ME intake) increased lamb liveweight gain.

To achieve maximum production from feedlot diets for lambs it is important to ensure that requirements for protein and minerals are monitored and supplied.



Management of a lamb feedlot

General management points to consider when operating a lamb feedlot

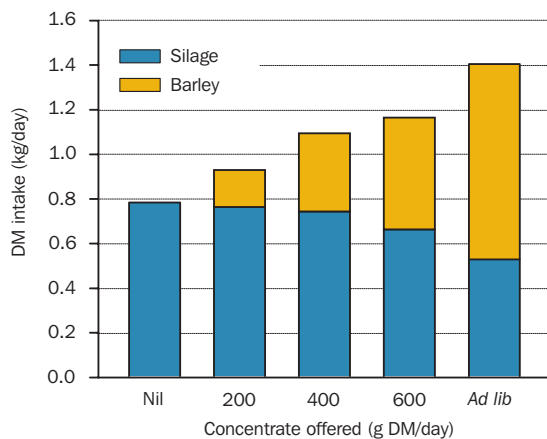
- Ewes fatten more quickly and are probably best turned off at liveweights of 38 to 40 kg. Wethers can be held to heavier weights without becoming overfat.
- Ram sires selected for leanness and higher post-weaning weights will produce faster-growing lambs. Where possible producers should obtain store lambs from sources that use selected rams.
- Lambs of liveweight <30 kg require a source of bypass protein (UDP) in the diet. Above 35 kg, rumen microbial protein synthesis will meet lamb requirements. In poorly preserved silage where degradation of the protein fraction is more extensive, additional protein supplements may be required for all lambs.
- As lambs mature muscle deposition decreases and fat deposition increases. Increasing energy levels in the diet produces carcasses with more fat.
- Grain feeding can produce fatter animals than pasture at the same body weight, particularly if dietary protein is inadequate.
- Feedlot designs can be obtained from local sheep advisory officers or from specific publications. Large feedlots may need development approval.

The Wagga Wagga study with mixed silage and grain (see Table 15.3) also showed that total DM intake increased when grain was fed with silage. Another Irish study (see Figure 15.6) clearly shows the change in silage DM intake when grain is fed at increasing levels. In this study the grain and silage were fed separately. At low levels of concentrate feeding, silage intake remained reasonably constant and there was no substitution of silage by grain. At slightly higher levels of concentrate feeding substitution occurred, but the decline in silage intake was considerably less than the increase in concentrate intake. At very high or unrestricted access to concentrate the decline in silage DM intake approached the increase in concentrate DM intake.

In practice, this means that producers should evaluate the additional liveweight gain achieved for the extra cost of adding grain. For low levels of grain in the diet the animal production response to grain will essentially be additional to the production achieved from feeding the silage alone and the additional liveweight gain can be valued against the additional cost of the grain. At the other end of the spectrum, when grain intake completely replaces silage DM intake, then the liveweight gain and expense of the grain needs to be compared with what was achieved with silage.

Figure 15.6

Effect of concentrate supplementation on the intake of perennial ryegrass silage by lambs.



Mean of two experiments. Concentrates were a mix of cereal grain and protein meal.

Source: Adapted from Black and Chestnutt (1992)

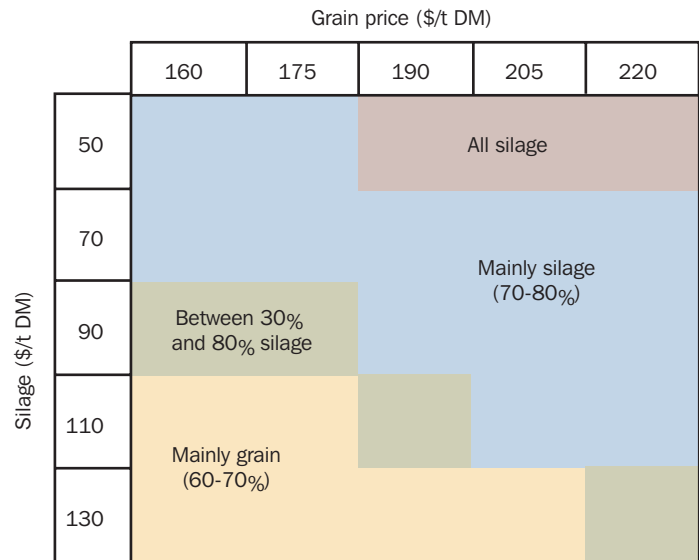
The proportion of grain included in the diet will depend on the level of production required and the relative price of grain and silage, taking into account their respective nutritive values. Meeting growth rate requirements and market goals is important. If the price of grain rises and/or that of silage falls, the diet will contain more silage and less grain. Figure 15.7 is based on the studies conducted at Cowra, NSW. It shows how the relative value of silage and grain will influence the proportions of each when formulating a cost-effective diet for lambs.

Silage and grain can be fed to sheep either mixed or separately. There is no clear evidence of any production advantage from either method. However, when feeding grain separately, it is important to manage grain intake to ensure the required proportion in the diet.

For most producers, the decision on whether to feed mixed rations or silage and grain separately will often depend on practical limitations, e.g. the feedout system.

Figure 15.7

*Effect of relative price of silage and grain on the most cost-effective diet composition for finishing lambs.**



* Based on silage with an approximate ME of 10.0 MJ/kg DM and grain with an approximate ME of 12.5 MJ/kg DM.

Section 15.4

Silage as a supplement to pasture

Seasonal feed shortages, quantity and/or quality, will occur at some stage in most years. In enterprises such as wether wool production, the animal's body reserves can be used to meet a short-term energy deficit. However, in other sheep enterprises under-nutrition of growing lambs or weaners, or of the ewe at critical stages of the breeding cycle, can result in significant production losses, or even mortalities.

There are many situations where paddock feed will not meet the animals' energy and protein requirements and will have to be supplemented, particularly when producers are targeting high levels of animal production. In these situations, silage can play a valuable role as a supplement to pasture in many sheep enterprises and can also be used as a pasture management tool (see Chapter 3).

Silage provides a source of energy and protein and, in most cases, it can be interchangeable with other supplements when formulating diets. However, consideration needs to be given to a possible lower intake of silage when compared to pasture of equivalent quality, and to issues that can influence the production response to silage, such as fermentation quality, DM content, chop length and feedout system (covered in Section 15.2).

Sheep are very selective feeders and will consume a diet of the highest quality available. When supplementing grazing sheep, the quality and availability of the pasture selected will govern intake and animal responses to silage supplements. Programs such as Grazfeed® can be used to predict likely consumption and production for various pasture and silage supplementation scenarios.

The two pasture scenarios likely to give a production response from supplementing sheep with high-quality silage are:

- ▶ When limited pasture availability restricts intake. Pasture can be of high or low quality. This is common in southern Australia from autumn through winter, when pasture quality is high but pasture availability is below animal requirements.
- ▶ When pasture quantity is non-limiting but quality is low. Provision of a higher quality silage supplement will increase sheep production and may even stimulate intake of the pasture. This intake stimulation may occur when the silage nitrogen content is high.

Most of the time, the pasture situation will lie between these extremes. Whether supplementation with silage will improve sheep production will depend on the silage quality, class of sheep and the ability of the sheep to select a diet from the pasture that is of higher quality than the silage, and in sufficient quantity.

Role for silage as a supplement to pastures

- ▶ Ensuring the survival of weaners on dry feed in summer and early autumn.
- ▶ Maintaining ewes in a satisfactory condition during late pregnancy and lactation to avoid excessive lamb losses and to increase lamb growth rates.
- ▶ Increasing the fertility of ewes by increasing liveweight prior to joining.
- ▶ Finishing lambs/young sheep to market specifications.
- ▶ Drought feeding of all classes of stock.

15.4.1

Supplementing the breeding flock

Supplementary feeding with silage can improve productivity if low pasture availability and/or quality coincide with critical stages of the breeding cycle. Joining, late pregnancy and early lactation are the critical stages when good nutrition is important. Ewe weight change should be monitored during the breeding year to ensure that weight is relatively constant at the start and finish of the breeding period. As demonstrated in Table 15.10, and also in Table 15.16, silage can be used successfully to increase the liveweight gain of ewes where a feed gap limits production. In the former study, dry ewes grazing autumn pasture (in New Zealand) lost 15 g/day, but gained 60-80 g/day when given a wilted pasture silage supplement of 0.7-1.0 kg DM/day. In the New Zealand study in Table 15.16, silage supplementation improved ewe liveweight gain, with the best responses being observed with the earlier cut silages. This confirms that the improved sheep production responses observed on higher ME content, earlier cut silages discussed earlier (see Section 15.1), also applies when silage is used as a supplement to pasture.

Plate 15.4

High-quality silage will maintain or increase bodyweight of pregnant ewes during periods of poor pasture availability. Photograph: D. Stanley



Wilting of the late-cut silage increased silage intake and liveweight gain (see Table 15.16). However, while reducing the chop length of the early cut silage, increased silage intake did not increase total DM intake, and as a result there was no improvement in liveweight gain with shorter chop length. The length of the chopped material in this study is quite long for precision chop silage (100 mm), is not common practice and much longer than would be recommended. It is likely that shorter chop lengths would have increased total DM intake, ewe liveweight gain is likely to have increased as a result.

Table 15.16

	Pasture alone	Early cut silage supplement		Late cut silage supplement	
		Wilted long	Wilted chopped	Unwilted long	Wilted long
Silage DM content (%)	–	36.8	34.8	18.4	33.0
Pasture intake (kg DM/day)	0.9	0.6	0.4	0.9	0.6
Silage intake (kg DM/day)	–	1.0	1.2	0.6	1.0
Ewe liveweight change (g/day)	-12	100	102	61	75

*Response by ewes grazing restricted pasture to early or late-cut, unwilted or wilted ryegrass silage supplements.**

* Early and late cuts were at the pre-ear emergence and ear emergence growth stages, respectively. Silages were harvested with a flail harvester (long) or a precision chop harvester (chopped, 100 mm).

Source: Rattray et al. (1978)

Higher liveweights and an increase in liveweight before joining (flushing) can both improve the ovulation rate of ewes, and result in an increase lambing percentage (fecundity), although the effects are often difficult to separate. Providing the ewes are in adequate body condition, it has been estimated that every 1 kg increase in liveweight could increase the lambing rate by 1.5-2%, independently of any flushing response. The flushing response is more difficult to predict and depends on a range of factors. It has also been found that some feeds, lupin grain in particular, can have a large effect on ovulation when fed at a specific stage of the oestrous cycle, independent of liveweight. This effect is likely to be due to the particular composition of the feed. It is

not known if silage will trigger this additional response. However, the absolute increase in liveweight due to silage supplementation prior to joining should lead to increased ovulation rate (and lambs born), regardless of any additional flushing effect.

The effects of liveweight on lambing percentage were confirmed in a separate on-farm study in New Zealand, where a small silage supplement reduced liveweight loss in ewes. The lambing percentage was 16% higher for the heavier supplemented ewes compared to the unsupplemented ewes (see Table 15.17). All ewes lost weight in this study and there would have been no flushing effect.

Good nutrition in late pregnancy ensures adequate body condition at lambing and reduces the risk of pregnancy toxaemia, which is particularly relevant for ewes bearing multiples. High-quality silage can be used to supplement pregnant ewes when pasture supply is inadequate to meet animal requirements.

When ewes lamb in good body condition, milk production and lamb growth are unlikely to respond to supplementary feeding unless pasture availability and/or quality is low during early lactation. Increased ewe liveweight may be the only response to supplementation if pasture quality and supply is not limiting.

Table 15.17

*Effect of silage supplementation of ewes during autumn for 43 days on liveweight change and subsequent lambing percentage. **

	Unsupplemented	Silage supplement
Pasture intake (kg DM/day)	0.6	0.7
Supplement intake (kg DM/day)	–	0.3
Liveweight change** (kg)	-4.4	-1.1
Barren ewes (%)	4	5
Lambs born/ewe	1.04	1.21

* Rams introduced within 30 days of the start of supplementary feeding.

** Liveweight change over 43-day period.

Source: Piggot et al. (1978)

15.4.2

Supplementing lambs and weaners

Silage can be used as a supplement for weaned or unweaned lambs in a meat production or wool enterprise.

The focus is on a high survival rate and maintaining a moderate level of lamb growth when supplementing weaner lambs as part of a replacement program for a wool flock. In a meat operation, the aim will be to achieve high liveweight gains, cost effectively. The exception to this is where producers attempt to slow down growth rates in order to manipulate supply and timing to access particular higher price markets.

While consumers of lamb meat have expectations of a consistent high-quality product being available throughout the year, achieving consistency of supply and quality is difficult for meat production systems that are based on dryland pasture. In southern Australia these pastures are predominantly winter/spring growing, with an unreliable autumn component. Traditionally, most lambs sold for slaughter are unweaned and enter the market for a limited time, governed by pasture availability.

Lamb liveweight gain depends on the quality and quantity of available pasture and is highest when available pasture is about 1500 kg DM/ha, with digestibility >70% and containing a legume content of at least 30%. Quality of these pastures declines quickly as they mature, and carry-over summer feed is of poor quality.

Plate 15.5

Silage is an effective supplement for lambs to maintain growth rates during periods of low pasture availability.

Photograph: D. Stanley



Not surprisingly, the quality and supply of lamb meat has historically reflected this.

New market demands for heavier carcasses will carry further seasonal risk because the heavier slaughter weights require lambs be held for 2 to 3 months longer than for the traditional domestic market.

Supplementation is an option that is now widely used in prime lamb production in response to this market-driven demand for heavier carcasses. It can also be used in conjunction with feedlotting to manage grass seed contamination, freeing up paddocks and improving cash flow by adding value to finished lambs.

In a study conducted at Cowra, NSW, lambs grazing lucerne pasture were either unsupplemented or supplemented with lucerne silage or oat grain (see Table 15.18). Supplementation reduced the pasture requirement while at the same time increasing lamb liveweight gains.

Table 15.18

Effect of supplementation with oat grain or lucerne silage on liveweight gain of lambs grazing lucerne pasture.

	Control	Oat grain	Lucerne silage
DM intake (g/day):			
Supplement	0	380	390
Lucerne pasture	1,480	1,050	1,330
Total	1,480	1,430	1,720
Liveweight gain (g/day)	139	166	167
Predicted animal production:*			
Stocking rate (lambs/ha)	32.18	45.35	35.80
Lamb production (kg/ha)	188	316	251
Total supplement fed (kg DM/ha)	0	724	586
Additional lamb production (kg)	–	128	63
Additional income (\$/ha)	–	100.08	66.52

* Assumes 2 t DM/ha of pasture available, consumed over a six-week period and no wastage of the supplement fed.

Additional income calculated based on oat grain \$180/t DM, lucerne silage \$80/t DM, and lambs \$1.80/kg liveweight.

Source: Holst (unpublished data)

An option to capitalise on this would be to increase stocking rate and keep rate of pasture usage constant. Alternatively, leaving the stocking rate unchanged could extend the pasture life, however, the impact of declining quality with maturity on sheep production would need to be considered. Reducing grazing pressure may also help to maintain a better species mix in the pasture. Table 15.18 shows the lamb production achieved for the various options and the predicted increase in lamb production and income per hectare if stocking rate is increased and pasture usage rate remains constant.

In the above study, the highest income per hectare was achieved by supplementing lucerne pasture with oat grain. However, this does not take into account extra pasture management or animal health benefits that may exist when a

silage-making strategy is incorporated into the whole farm plan, demonstrated in the example below.

A Tasmanian study compared production from crossbred lambs during summer/autumn which were grazed on either regrowth pasture after a spring-conservation cut, or pasture that had been grazed throughout spring. The yield of the two pastures was similar, but the proportion of green leaf was greater for the regrowth. All lambs were drenched prior to the commencement of the study (7 January) and supplemented with access to pasture silage *ad lib* (61% OM digestibility) at all times from 22 January. Lambs on the spring-grazed pasture were drenched again on 6 March. As can be seen in Table 15.19 lambs grazing the regrowth had lower worm burdens and produced 114 kg of additional liveweight gain per hectare.

Table 15.19

Liveweight gain (g/day) and parasitic worm burden (eggs/g faeces) of crossbred (Border Leicester x Merino) lambs grazing pastures previously cut for hay (regrowth) or grazed during the spring.

Date	Mean liveweight gain (g/day)		Ova count (eggs/g faeces)			
	Regrowth	Grazed	Regrowth		Grazed	
			Strongyloid	Nematodirus	Strongyloid	Nematodirus
7-23 Jan*	278	168	0	0	0	0
23-5 Feb	234	98	0	0	120	0
5-22 Feb	110	101	15	15	720	90
22 Feb-6 Mar	97	-26	30	15	1,515	150
6-19 Mar*	45	59	15	60	0	0

* All lambs were drenched 7 January and the group on the grazed pasture drenched again on 6 March.

Source: Beattie et al. (1992)

Section 15.5

Silage as a drought (or long-term) reserve

Silage is a valuable drought feed and silage conservation is an important drought-management strategy on many properties. High-quality silage can be used during drought either to maintain livestock or as a production feed (usually with a component of grain in the diet) to finish animals for sale at higher value.

The cost of silage conservation as a drought strategy only is often difficult to economically justify because of the capital outlay which may not be recovered for several or more years (cost of conservation and storage). Economic viability of silage-making for drought only will depend on the cost of conservation, storage life, silage quality, purpose for which the silage will be used and the relative cost of other feeds which may be available during a drought. Incorporating a conservation strategy into the annual farm program will reduce overhead costs (and total cost) per tonne of silage fed.

A drought reserve can be created by opportunistically conserving more of the surplus pasture in the better seasons. Regular silage making is likely to be restricted to the more favourable sheep production areas. In drier areas, making low-cost silage during exceptional years could be possible, but if it were only to be used as a drought reserve, the economics would have to be considered carefully.

If the silage is to remain well preserved for long periods, particular attention must be paid to silage storage technique (see Chapter 9, Sections 9.4 and 9.9).

Plate 15.6

Silage can provide high-quality feed during drought to all classes of sheep, including pregnant ewes. High-quality silage allows the flexibility for production feeding or for use as a maintenance ration. Photograph: D. Stanley



Even when silage is to be used as a drought reserve it is important to maximise silage quality. High-quality silages allow producers to use the silage for production or maintenance only (by restricting intake). Poorer quality silages cannot be used for production unless supplemented with a high energy source, e.g. grain. Although the cost of producing high- and low-quality silages per tonne is similar, the conservation and feedout costs per unit of energy (ME) fed are lower for the high-quality silage. Table 14.26 (Chapter 14) has a worked example of the relative cost of maintaining a herd of cows fed silage varying in energy content from 7 to 10 MJ ME/kg DM. The same principles apply for any sheep operation.

Section 15.6

Silage feeding and meat quality

Feeding silage or silage-based diets to lambs for meat production will produce carcass weight gains typical for lambs fed non-silage diets of similar quality and DM intake, with no adverse effects on carcass composition or meat quality. Carcass composition appears to be largely dependent on carcass weight and it is not likely to be adversely affected by manipulation of weight gain, unless applied as a severe nutritional stress early in life.

In the study at Wagga Wagga, NSW, presented in Table 15.3, the lambs were slaughtered when they reached approximately 45 kg liveweight. A summary of the results and carcass details are presented in Table 15.20. All the diets produced carcasses of similar weight and with similar levels of tissue cover at the GR site, irrespective of the proportion of grain and silage in the diet. GR measurements were considered normal for these carcass weights.

In a Tasmanian study (see Table 15.21), two groups of crossbred lambs were grazed on a dryland perennial ryegrass/ cocksfoot/white clover pasture for 60 days, with one group being supplemented with pasture silage *ad lib* for the final 30 days. A third group was grazed on a similar pasture that was irrigated and was not supplemented with silage. When 50% of the lambs on irrigated pasture exceeded 48 kg, then all lambs from the three groups exceeding this weight were slaughtered. This was to ensure carcasses in the range 18-26 kg.

Table 15.20

Production from crossbred (Border Leicester x Merino) lambs fed mixed subclover silage and grain diets.

	Grain type							
	Nil	Barley			Barley/lupin			
Grain in the diet (%)	0	25	50	75	25 (79:21)*	50 (79:21)	75 (79:21)	75 (66:34)
Silage:grain ratio	100:0	75:25	50:50	25:75	75:25	50:50	25:75	25:75
Diet crude protein (%DM)	17.9	16.8	15.6	14.5	17.9	17.9	17.9	20.0
Diet ME (MJ/kg DM)	9.5	10.2	11.0	11.7	10.3	11.1	11.8	11.8
Fasted liveweight (kg)	40.3	41.2	44.0	43.9	42.7	47.4	47.1	46.5
Hot carcass weight (kg)	20.8	20.6	19.9	20.2	20.2	19.3	19.1	19.5
GR** (mm)	15.8	16.1	15.5	15.3	15.6	15.6	15.1	15.9

* Ratio of barley:lupins shown in brackets

** GR is tissue depth over the 12th rib 110 mm from the midline.

All carcass weights and fat depths were adjusted to a common fasted liveweight of 44 kg.

Source: Adapted from Datta et al. (1992) and Graham et al. (1992)

Lambs that grazed the irrigated pasture grew faster, were heavier at slaughter and had heavier carcasse weights. A taste test panel noted that only the meat from lambs that grazed dryland pasture, with no silage supplement, had a stronger aroma and flavour, and was less acceptable (see Table 15.21). However all samples, on balance, were considered acceptable and the average consumer would be unlikely to detect the difference.

Table 15.21

	Pasture and silage	Pasture	Irrigated pasture
Pre-slaughter liveweight (kg)	51.6	52.5	55.4
Fatscore (1-5)	2.8	3.0	3.2
Hot carcasse weight (kg)	23.2	23.2	25.0
Dressing percentage (%)	44.5	44.2	45.0
Hot GR* (mm)	13.0	13.0	13.4
Aroma	5.2	6.4	5.3
Flavour	5.1	5.5	4.7
Acceptability	4.9	5.4	5.6

Effect of diet on carcasse and meat characteristics of crossbred (Border Leicester x Merino x Poll Dorset) lambs.

* GR measurement adjusted to a mean hot carcasse weight of 23.9 kg.

Six samples per group were evaluated by a taste panel.

Higher values indicate a stronger flavour and aroma, for acceptability 1=high and 9=low.

Source: Hopkins et al. (1998)

Plate 15.8

Silage-based diets can be used to produce high-quality lamb carcasses for domestic or export markets.

Photograph: D. Stanley

