Chapter 11

Assessing the economics of silage production

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In this chapter

The author

B.L. Davies

Department of Primary Industries, Tocal Agricultural Centre, 'Tocal,' Paterson, NSW

Key Issues ... see Page 278

The Key Issues

- The cheapest forage is usually grazed in the paddock. Conserved forage is often only valuable when there is a feed gap that cannot be filled by producing pasture or a forage crop.
- To justify conserving forage, it must either be cheaper to make than growing additional forage to graze or buying an alternative feed, or there must be other benefits to outweigh the additional costs. Investment in fodder conservation equipment must also provide a reasonable return on the capital.
- While there are substantial differences in the costs and benefits of the various forage production systems, there can also be large differences in similar operations.
- The whole farm benefits of forage conservation need to be considered. Benefits include:
  - forage conservation can be a good pasture management tool, resulting in improved quality of pasture regrowth;
  - forage reserves can justify higher stocking rates and improve pasture utilisation; and
  - forage conservation can reduce costs such as slashing and weed control.
- The benefits of the regrowth following the making of an early silage crop are generally under-valued.
- Machinery costs, especially overhead costs, can be high and throughput needs to be sufficiently high to justify ownership of expensive equipment. Contractors are usually a cheaper option on smaller holdings.
- All labour, including family labour, should be costed. The labour requirements of some feedout systems are very high, making them uneconomic. Investment in more efficient feedout equipment will often be the most cost-effective forage conservation investment that a farmer can make.
- The economics is greatly influenced by the quality of feed produced. It is usually more profitable to harvest earlier and produce a higher-quality forage than to wait for maximum yield. Costing of forage should be on the basis of what is most limiting. For example, if energy is required it should be costed on an energy (MJ) rather than on a weight basis. If protein is the limiting factor, forage costs should be compared on a per unit of protein basis.
- Minimise losses. Losses in the forage-making process occur at harvest, transport to storage, in storage and during the feedout phase. Total losses can exceed 30% and add considerably to the 'as fed' costs of any forage.
- Contract growing of forage by a neighbour may become more common, especially in areas where transport costs for alternative feeds are high.
- Many of the principles considered in this chapter apply equally to silage and hay production.
- A computer-based decision aid has been developed to help dairy, beef and prime lamb producers compare the economic merits of forage conservation systems. The *Forage Systems Model* compares the present system with the proposed system and calculates the return on capital likely from the additional machinery investment.

Section 11.0

Introduction

A 'whole farm' approach is needed to properly assess the economics of forage production.

The process of forage production affects other things on the farm. For example, one of the benefits may be a higher stocking rate and better pasture utilisation.

After taking into account any indirect consequences – both positive and negative – the economics of forage production could be justified when:

- the cost of the forage is less than alternative feed sources on an energy or protein basis, and
- the net result (income from feeding the forage minus all the costs of producing it) provides a satisfactory return on the additional capital required.

This chapter:

- outlines the potential economic benefits from forage production and the costs involved (see Sections 11.1 and 11.2);
- discusses strategies to reduce costs;
- emphasises the importance of striving for quality (see Section 11.3);
- examines some of the risk issues from an economic perspective; and
- highlights the substantial variations between forage production systems (for an example, see Appendix 11.A2).

There can also be large variations in the benefits and costs when similar production systems are compared. Producers should use their own cost and production figures to realistically assess the impact of a forage production system.

While the focus in this chapter is on silage production, the principles apply equally to hay production.

To help producers with their calculations, a computer-based decision aid has been developed by this author. The use of the *Forage Systems Model* (a costing analysis of forage conservation systems) will assist the dairy, beef and lamb producers or their advisers assess the benefits and costs of forage production. Section 11.5 contains information on how to access a copy of this model.

Plate 11.1

Harvesting surplus pasture can be a cheap source of feed and can be a valuable pasture management tool.

Photograph: F. Mickan

Section 11.1

Benefits of silage production

The likely financial benefits of a forage production system will vary between animal production enterprises and include:

- Increased stocking rates.
- Forage can be transferred from a time or place where it can be grown cheaply to replace more expensive feed when there is a feed shortage.
- It can be the cheapest supplementary feed source to fill feed gaps and balance rations.
- Pasture management benefits may lead to improved pasture utilisation, production and quality, resulting in greater milk or meat production.
- A wider range of enterprise choices may be available, allowing producers to:
  - reach production targets faster;
  - access new markets; and
  - cash-in on periods of premium prices or production bonuses.
- Savings in slashing or weed control costs.

The value of the forage

The forage's value can be estimated by:

1. The cost of the equivalent purchased feed (opportunity-cost method).
2. The net income received from meat or milk produced as a result of feeding that forage (value-added method).

Method 1 should be used where purchased forage can profitably do the same job as conserved forage. Use Method 2 when purchased feed is too expensive and cost outweighs the production advantage or where there is no infrastructure to handle purchased feed.

The main sources of raw material for forage conservation are surplus pasture, crops grown specifically for forage production and off-farm by-products.

Each source can provide cheap feed. However, the forage crop growing costs must be included when calculating the cost of feed. Crop costs are discussed further in Section 11.2.5; Appendix 11.A1 gives an example of maize growing costs.

Section 11.2.6 covers the opportunity cost of lost grazing due to closing a paddock for forage conservation. This cost is usually minimal because the only paddocks that are used for forage conservation are those that are surplus to grazing requirements. The exception may be where large quantities of forage are needed for feeding outside of the growing season: some supplementation can be justified during the forage conservation period to release the required quantity for conservation.

Potential advantages

Increased stocking rates: Once forage has been made and stored, farmers have access to a buffer of feed, which may allow increasing stocking rates. This can improve pasture management, resulting in improvements of both quality and quantity of feed (see Chapter 3).

Increased pasture utilisation: Controlling the pastures in periods of rapid pasture growth can increase pasture utilisation. By maintaining pastures in a vegetative phase as long as possible, greater overall production and improved pasture quality can result (see Chapter 4). Silage or hay making can mean that pasture growth is better controlled and utilisation increased .

Savings in slashing, weed control costs: The timely harvest of surplus growth for silage production can prevent pastures becoming rank and so avoids the expense of slashing or mulching and the additional penalty of slow pasture growth because of slashed material covering the pasture.

Silage making can also prevent weeds setting seed. The ensiling process usually renders weed seeds non-viable and can reduce the bank of weed seeds in the soil (see Chapter 3, Section 3.3).

Section 11.2

Costs of forage conservation

It is important to consider all the costs involved in forage conservation. Besides machinery and labour, there are pasture or crop growing costs, the opportunity cost of lost grazing when paddocks are closed up, harvesting costs, storage costs and feedout costs.

Losses can vary greatly between systems and between farms, so it is important to identify and minimise wastage. This will, in turn, reduce the cost of silage on a fed basis.

Cost calculations are on a fed basis ($/t DM fed) – on the quantity and quality of product that is actually consumed by the animals (see Section 11.2.4).

11.2.1

Machinery costs

Machinery costs incurred in forage conservation can be calculated by substituting your own figures into the examples provided in Appendix 11.A2.

The traditional method is to include the variable costs (e.g. fuel, oil, repairs, tyres) for machinery that is already owned and used outside the forage conservation system.

For specialist machinery, and any purchases required as a result of changes to the forage conservation system, both variable and overhead costs should be included.

It can be argued that if a change in a system causes additional usage for a machine that is also used for other purposes (e.g. tractor), some of the depreciation will be due to the additional usage. The *Forage Systems Model* allows for the option of allocating a portion of the overhead costs for dual purpose machinery towards the forage conservation costs.

Fixed or overhead costs

Fixed costs, or ownership costs, do not vary with usage. You pay these costs every year, regardless of whether you use your machine for 10 hours or 1,000 hours. Owning expensive forage conservation equipment can only be justified if there is adequate throughput to spread the overhead costs. Where possible, the harvest period should be extended by having a range of crops or pastures with a range of maturities.

Insurance, shedding, workshop and registration are among the fixed costs, but the two major costs are depreciation and interest.

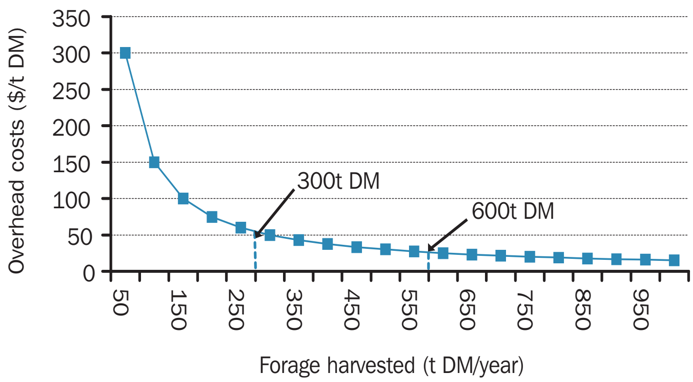
Depreciation

A straight-line depreciation method is the simplest way to estimate machinery depreciation. Take the price of the new machine (ignoring trade-in effects), subtract the estimated trade-in value you expect to get when you think you will sell it and divide by the number of years.

Depreciation cost/year =
(purchase price – trade-in value)
÷ number of years used

Figure 11.1

Effect of usage on overhead costs of forage conservation machinery.



Interest

Interest (or opportunity cost) is the cost of using money. If you had invested your money instead of using it to buy the machine, it would have generated income at the rate earned on the investment. If you need to borrow to buy the machine, the rate will be the borrowing rate.

Interest cost =
average value x interest rate

Average value =
(purchase price + trade-in value) ÷ 2

Where machinery is used in activities other than forage conservation, estimate the proportion of the machinery use for forage conservation to work out the proportion of the overhead costs.

The effect of machinery usage on interest and depreciation costs

Figure 11.1 shows the effects of annual forage production on overhead costs and the costs per tonne of forage conservation for machinery worth $100,000, with a life of 10 years and an interest rate of 10%.

Based on these assumptions, Figure 11.1 clearly shows that more than 300 tonnes of DM a year needs to be made before overhead costs fall to $50/t DM. Doubling the quantity harvested to 600 t of DM halves the overhead costs to $25/t DM.

Although smaller farms may be able to operate with less equipment and the machinery may last for more than 10 years, the shape of the graph is still the same and there will be significant cost reductions on a per tonne basis if the quantity harvested can be increased.

In many regions, there are a number of ways to increase machinery use:

- use pastures and forage crops with varying maturity dates and staggered closure to spread the harvest period;
- use lucerne, maize or other summer species to provide a harvest outside the main spring season;
- contract, especially in other districts where the harvest season is earlier or later than your season;
- harvest a greater area;
- ensure there is sufficient labour available at harvest to operate machinery to full capacity;
- ensure that machines are given a thorough check prior to harvest to minimise the risk of breakdowns;
- hold key spare parts; and
- form a syndicate to share the machinery among a number of farmers.

Where usage is still low, farmers should consider using a contractor (see Section 11.2.3).

Plate 11.2

Machinery such as this can save time but the usage must be high to spread the overhead costs.

Photograph: K. Kerr

Timeliness costs

A timeliness cost is a reduction in returns (or an increase in costs) caused by an operation not being completed within the optimal time.

The quality of forage deteriorates if harvesting is delayed past the optimal time. It can be a large cost to silage production. If there are excessive delays between harvest and sealing, there can be additional losses. These factors are covered in detail in Chapters 2, 6, 8 and 9. The economic consequences of timeliness, in relation to quality losses, are discussed in Section 11.3.

Although timeliness costs are more likely to occur because a contractor could not arrive on time, they can also occur when the farmer's own equipment is used. The machinery capacity may be insufficient, there may be a machine breakdown at a critical time or other priorities may delay forage conservation. Losses due to timeliness will vary depending on the circumstances and are difficult to forecast.

Variable costs

Variable (or operating) costs are those costs that vary in proportion to machinery use.

The main variable costs for tractors and other engine-powered machines include fuel, oil, filters, tyres, tubes, batteries and repairs. For implements and other non-engine operated machinery, variable costs can be repair and maintenance costs plus twine and plastic costs in the case of baled silage.

A rule of thumb is to allow 3% of a new tractor's cost per 1,000 hours of operation for repairs and maintenance and 4% per 1,000 hours for tyres, tubes and batteries. For non-powered machinery, a figure of 5% of new cost per 1,000 hours is suggested. Fuel costs can be calculated from the rated litres per hour by the price of diesel per litre, after rebates. Oils and filters are generally costed at 10-15% of the fuel price.

Machinery work rates

Machinery work rates are important because, along with hourly costs of operating the machine, they determine the machinery variable costs.

Work rates are also important in calculating labour costs (see Section 11.2.2).

Machinery work rates can be determined by the formulae:

$$\text{Work rate (ha/hr)} = \frac{\text{width (m)} \times \text{speed (km/hr)} \times \text{an efficiency factor}}{10}$$

$$\text{Work rate (hr/ha)} = 1 \div \text{workrate (ha/hr)}$$

The efficiency factor is included because the machine is only working for a portion of the time. There are repairs, maintenance and stoppages to consider. Efficiency for most operations is likely to be around 80%.

For example, if a 3 m mower-conditioner operates at 9 km/hr and has an 80% field efficiency, the work rate is:

$$\frac{3\text{ (m)} \times 9\text{ (km/hr)} \times 0.8}{10} = 2.16\text{ ha/hr}$$

$$\begin{aligned}\text{Work rate per ha} &= 1 \div 2.16\\ &= 0.463\text{ hr/ha}\end{aligned}$$

Syndication

Syndication in silage production involves sharing machinery or labour to reduce costs. This allows overhead costs of machinery to be reduced, with a higher throughput and a larger source of labour used to keep the machinery operating. Often only one key machine, such as a baler, is syndicated.

There are a number of important guidelines to running a successful syndicate. The areas to get right include adequate communication between members, fair sharing rules and operating the machine under sound business management principles.

If circumstances change, syndicate members must have sufficient business knowledge and rules to be able to fairly adjust the membership or cease operation so that all members are treated equitably.

11.2.2

Labour costs

Family labour costs should be included in calculations at award wage rates. A higher rate can be justified for the farm manager. It is important to account for family labour as it can always be used productively for other activities, either on or off the farm.

The value of employed labour should be included at the relevant hourly rate, including costs of workers' compensation and any other compulsory costs. Allow 20-25% on top of the wage for these.

Labour costs depend on the type of labour used – casual, permanent or the farmers themselves. Casual labour costs are quoted on a 'per hour' basis.

Although permanent or family labour is often not costed as a variable cost, it should be included. The hourly cost is the value of the labour if it were spent on the most profitable alternative operation or the value you place on your leisure time.

Due to factors such as downtime in machinery maintenance and setting up, the labour required is often 20-30% more than the actual machinery operation time.

11.2.3

Contracting costs

It is often impossible to justify ownership of all of the machinery required for a forage conservation operation. This is especially the case in smaller operations where limited usage results in high overhead cost per bale, per hour or per tonne (see Section 11.2.1).

Table 11.1 gives a range of contractor prices for key operations. These are indicative rates only; costs will be influenced greatly by factors such as the local competition between contractors, prevailing fuel prices, the size of the equipment, the carting distance from paddock to storage site, the size of the job and the proximity to the contractor's base.

The contract prices used in this chapter will date quickly. Local rates should be used, with quotes from several contractors to ensure the quotes are competitive. Some of the major rural newspapers publish sample contract rates on an annual basis. Contact with other farmers who use contracting services is another way to establish the market rate.

Table 11.1

Examples of contract rates for various operations required in the silage-making process.

Operation	Example rates for 2001 (GST inclusive)
Mowing	$39.50/m of width/hr, $47/ha
Mower-conditioning	$43/m of width/hr or $60.85/ha
Raking	$22/m of width/hr or $35.70/ha
Tedding	$17-$22/m of width/hr or $35.70/ha
Baling large squares (hay)	$11-$24.55/bale depending on size (raking extra)
Baling large squares (silage)	$12-$18 depending on size (raking extra)
Round bale (hay)	$8.50-$16 depending on size (raking extra)
Round bale (silage)	$9-$11.30 depending on size and location (raking, net wrap extra)
Wrapping round bales	$6.05 + plastic
Wrapping large square bales	$7.90 + plastic
Self-loading forage wagon	$170-$190/hr
Tractor hire (including driver)	$0.80/hp/hr
Precision chop silage	$6-$10/tonne wet
Truck hire for carting silage (including driver)	$55-$60/hr

Source: Various; including Weekly Times 31 October 2001, p81; NSW Agriculture, Department of Agriculture WA

Plate 11.3

Contractors may be the only economical solution for some operations, especially when the scale of operation is small. *Photograph: N. Griffiths*

When quoted a rate, check whether it includes GST. Get the quote in writing and check that it clearly states the unit price on which it is based. For example, is it per bale, per tonne (wet weight), per hectare or per hour.

Table 11.1 includes example contract rates based on published material, mainly obtained in 2001. Because rates can vary, these rates should only be used as a guide for preliminary budgeting purposes. If preliminary budgeting indicates that contractors may have a place in your system, actual quotes should then be obtained.

Appendix 11.A3 contains a list of contacts for contract rates.

Ownership versus contract

Harvesting is the most common contracting operation. This section discusses the costs of machinery ownership, and the advantages and disadvantages of contractors.

To illustrate the effect of scale of operation on various forage conservation options, the Kondinin Group compared ownership and contractor costs and owner-operator labour costs for making 50 t DM, 250 t DM and 500 t DM of forage (see Table 11.2). Ownership options (darker shaded rows) in the range of case studies were more expensive at low production levels (50 t DM). At 250 t DM, contract round bale hay and contract wrapped silage were more expensive, but similar for the self-loading forage wagon.

This analysis is on the basis of cost per tonne DM, with no reference to silage quality. Forage quality is very important to the economics and delays in silage making can significantly lower silage quality (see Section 11.3).

Advantages of contracting include:

- no capital tied up in harvest machinery and so may be available for, e.g., a more efficient feedout system;
- less labour to organise;
- costs are running costs and therefore are fully tax deductible;
- contractors often have better machinery that can do the job more quickly or increase wilting rates.

Table 11.2

Effect of scale of operation on total costs ($/t DM) of making forage excluding owner operator labour (ownership options shaded).

	50 t DM	250 t DM	500 t DM
Round bale hay	95	30	19
Contract round bale hay	75	39	31
Wrapped silage	175	56	40
Contract wrapped silage	135	100	95
Self-loading forage wagon	142	35	20
Contract self-loading forage wagon	80	33	27
Contract precision chop	84	38	37

Source: Evans (1997b)

- some contractors have a good knowledge of silage-making principles and good machinery-operating skills that may result in a better quality product; and
- the farmer can concentrate on animal, crop and pasture management.

Disadvantages include:

- some contractors often book far more than they can comfortably handle and may be delayed;
- a crop may be harvested either under- or over-wilted;
- the contractor may have inadequate training in silage-making and storage principles;
- new labour often has to be trained at the start of the season;
- breakdowns or bad weather at a number of sites can extend delays;
- costs are likely to increase if access to paddocks and storage sites is restricted, e.g. narrow gateways;
- if not supervised, the contractor may make forage in unsuitable weather conditions; and
- there is a bill to pay.

Organising the contractor

Good planning and communication is essential.

The farmer should:

- Book the contractor early, giving an accurate indication of the area to be harvested. Give an approximate harvest date and ask about other bookings in that period. If bookings appear heavy, consider another contractor.
- Notify the contractor when you intend to start mowing and check when they can arrive.
- Make sure the paddock is clear of obstacles or notify the contractor of their location, e.g. burrows, wombat holes, rocks or tree stumps.
- If harvesting is the only job contracted, ensure the mowing and raking equipment is in good order to minimise the chance of breakdowns that will delay the contractor.
- Ensure the rake is well set up and suited to the job. A common complaint by contractors is 'ropey' windrows that cause blockages, slow throughput and may lead to breakdowns.

Get it in writing

Having a written contract helps safeguard against legal conflict. Considerations for each party to formally agree on include:

- Who pays for what if damage occurs, e.g. machinery hitting obstacles.
- The charging rate and acceptable measures, e.g. $/t DM, $/bale (light or heavy bales), or $/ha (light or heavy crops); the rate may also vary depending on the ease of doing the job, e.g. small versus large paddocks.
- The course of action if rain falls at various stages of the harvest;
- Who supplies the string, stretchwrap or sheet plastic.
- How long rolling of a pit may occur after harvest is completed.
- How long after baling storage and sealing will occur.
- Penalties for lapses in the agreement may be worth including.

There is often conflict between farmers requiring high-quality silage and the contractor who needs high yields to cover his costs, the greatest of which is machinery replacement.

11.2.4

Effect of losses on forage costs

Losses can occur at harvesting, storage and feedout. Depending on the standard of management, the combined losses can easily total more than 20% of the original parent forage. Losses occur in two ways:

- physical losses, when a portion of the original material is lost and is not available for consumption by the animal, i.e. DM losses; and
- losses because of a decline in quality.

If a feed that is cut for forage conservation is 11MJ/kg DM and falls to 10MJ/kg DM at feeding, there is a 9% loss in ME. The cause and likely extent of these losses is discussed in Chapters 2 and 8-10.

Storage losses vary with bunker size due to surface to volume ratio. Studies have shown that storage losses in feed bunkers in the United States dropped by 6-7 percentage units as storage capacity increased.

Table 11.3 provides a record of experimental results of losses that, even under good management conditions, can be significant. Losses under poor management can be much higher. Table 11.4 shows the final cost of the forage taking into account field, storage and feedout losses. Feedout losses have not been included in Tables 11.3, but will be very dependent on the system.

Losses could vary from as little as 1-2% when fed into troughs or onto pads, but are usually much higher when fed into paddocks. Attention to ways of reducing losses (see Chapters 2, 6 and 8-10) is vital to produce an economical feed supplement. When costing alternative feeds ensure that their losses are also accounted for.

Plate 11.4

Losses such as this can dramatically increase the costs of forage conservation.

Photograph: N. Griffiths

Table 11.3

Forage conservation losses (% DM) under conditions of good management.

Source of loss	Low DM silage (DM = 15-20%)	High DM silage (DM = 35-45%)	Hay (DM = 80-85%)
Field	2.8	6.7	18.9
Storage	16.5	6.3	4.2
Total	19.3	13.0	23.1

Source: Various sources -see Chapter 2, Section 2.5. The hay loss data have been derived from the same sources.

Table 11.4

Effect of DM losses on 'as fed cost of forage.'

Cost of making forage including storing & feeding* $/t DM	% losses in making, storing and feeding forage: 10	20	30	40	50
	As fed cost of forage (i.e. after losses) $/t DM				
$50	56	63	71	83	100
$75	83	94	107	125	150
$100	111	125	143	166	200
$125	139	156	179	208	250
$150	167	188	214	250	300

** This cost should also include the cost of the parent forage, as discussed in Section 11.1.*

11.2.5

Forage growing costs

The costs of growing a specialist crop must be included as a cost of the forage conservation system.

These costs include ground preparation, seed, fertiliser, herbicides, insecticides and irrigation. An example set of growing costs for a maize crop is provided in Appendix 11.A1. Farmers should complete their own cost estimates from previous records or seek advice from other farmers or advisers.

If extra costs are incurred when growing a pasture specifically for forage production, such as higher fertiliser inputs, these should be included as a cost of the forage system.

11.2.6

Opportunity costs of pasture set aside for forage conservation

Grazing opportunities may be sacrificed when a special crop is grown for fodder conservation or a paddock of pasture is closed up for several weeks before harvest. Lost grazing can have a cost. If, as a result of closing the paddock up, the cost of feeding the stock increases, or there are losses in the quantity of milk or meat produced, these costs need to be included.

Examples relevant to this scenario occur in dairying enterprises in the south-west of Western Australia, where the growing season is very short and roughage is required as part of the diet for the rest of the year. Where roughage of satisfactory quality can't be economically obtained off-farm, there may be a case to conserve forage, although the grazing animals will then require extra supplementation when paddocks are closed. In these circumstances, it is important to include the cost of the additional supplementation in the calculations.

However, as is often the case during spring, there is surplus pasture and production is not affected if some of the grazing area is withdrawn. Withdrawing an area for forage conservation can have benefits, rather than costs, such as improved production, with greater pasture utilisation or reduced slashing expenses.

11.2.7

Purchased feed costs

Purchased feed is a major cost in many high-production enterprises. Additional forage conservation may be carried out to reduce dependence on purchased feed while maintaining, or even improving, production levels. However, particularly in many dairy and beef finishing systems, the requirement for purchased feed may still be high.

A feed budgeting model is recommended to ensure accurate estimates of purchased feed costs are made and to help identify feed gaps and opportunities to conserve forage (see Chaper 1, Section 1.4.1).

Plate 11.5

Feedout costs can be very high. Highly mechanised systems can be justified if they save a lot of time and usage is high. *Photograph: N. Griffiths*

11.2.8

Feedout costs

Although feedout costs are made up of machinery and labour costs (see Sections 11.2.1 and 11.2.2), they are a very significant cost in most systems and justify special mention. Farmer research by Kondinin Group (see Table 11.6) demonstrated that the cost of feeding out hay and silage in 1997 was on average \$34/t DM, with labour making up more than 52% of the total feedout costs.

The most efficient system will depend on the scale of operation. A farm making large quantities of forage can justify spending more on machinery to speed up the delivery. Smaller operations may not be able to justify the capital-intensive, labour-saving devices.

Other factors to be taken into account are the losses likely from each system and if there is more production from using one system compared to another. Work in field testing the *Forage Systems Model* indicated that many farmers spend a considerable amount of time feeding out forage. In a number of cases, systems that significantly reduced this time were justified if the farmer costed their labour at market rates.

Economics of the location of forage storage

The decision on where to locate pits or stacks of forage should take into account the total feedout cost. This is not only the cost of getting harvested forage to the stack, but also the cost of feeding out, which can be high.

The filling operation can often be completed relatively efficiently but feedout is carried out over a much longer period and often with smaller equipment moving small quantities, so any inefficiencies can be costly.

Initially, it may be less costly to fill a pit that is close to the harvest site, but this site may 'cost' a lot more time at feedout. Some case studies testing the *Forage Systems Model* indicated that when machinery costs and labour costs are considered, feedout could be very expensive. Any modifications that could improve the efficiency of this process will result in a cheaper system.

11.2.9

Infrastructure costs

In analysing the use of forage as a means of increasing production, other costs involved with the expansion will have to be considered.

The implications of introducing forage conservation to the whole farm situation needs to be examined. For example, in a dairy situation, if more cows are milked, interest on the capital cost of the additional cows is a legitimate expense to include. Similarly, if extra vat or milking capacity is required, interest and depreciation on this additional equipment should be included.

In a situation where additional forage is to be used as a substitute for purchased feed, there may be no additional infrastructure to consider other than those costs directly spent on forage machinery.

11.2.10

Effect of bale weights and DM content on cost per tonne

Producers paying a contractor on a per bale or wet tonne basis should be converting the costs to a cost per tonne DM basis. To do this, the farmer must know the DM content and have weighed a sample of bales to know the wet weight of the bales.

Table 11.5 demonstrates the effect of DM content on bale costs. On a cost basis, dry bales are cheaper, but if quality is considered (MJ/kg DM) they may not be good value (see Section 11.3.5). There is the added disadvantage of potentially high field and storage losses when forage is ensiled at high DM levels.

Table 11.5

Effect of DM content and bale-making cost on cost/tonne DM ($/t DM).

Bale* cost	DM content of bale (%)		
($/t DM)	35	45	55
20	82	63	52
25	102	79	65
30	122	95	78

** Bale weight = 700 kg wet weight.*

11.2.11

Comparing costs of forage systems

There are significant differences between the costs of various forage conservation systems. Costs of any system are influenced significantly by the economies of scale, with costs decreasing as the amount of forage conserved increases. Research by the Kondinin Group (see Table 11.6) compared the costs of forage conservation systems on dairy farms. Costs for each system are averages of the individual conservation systems surveyed from mowing through to feeding out.

Note that besides cost/t DM, other factors need to be included in any final evaluation of systems. As discussed in Section 11.3, the quality of the forage produced is very important, and although the convenience of different systems is very difficult to value, convenience is also important.

From the limited sample, direct chopped crops were the cheapest system to use, costing an average $52.28/t DM, from chopping to feedout.

Forms of precision-chopped silage were less than half the price of other systems, costing an average $66.50 to $76/t DM to mow, chop, cart, roll, store and feedout.

The most expensive system was round bales of individually wrapped silage, costing an average $138/t DM.

The lowest cost for an individual system was $19/t DM for a precision chopped silage system, and the highest cost was $210/t DM for round bales of wrapped silage.

The high average cost of feedout for the self-loading forage wagon systems may be due to the small sample. A larger sample size is needed before conclusions can be made.

High-cost systems are generally associated with low throughput. In these situations contractors should be considered to undertake harvesting.

Table 11.6

Range in costs of forage conservation systems ($/t DM).

System	Low	Average (incl. feedout)	High	Average harvest cost	Average feedout cost
Small square bales of hay	60	92	119	69	23
Round bale hay	23	82	167	48	34
Direct chop silage	19	52	122	22	30
Pick-up precision chopped silage	38	67	121	34	33
Self-loading forage wagon	37	109	173	47	62
Wrapped round bales of silage*	82	138	210	105	33

* *With increased bale dimensions and the option to bulk wrap, bale silage costs have probably reduced since this survey was taken.*

Source: Evans (1997a)

Section 11.3

Quality versus quantity – the effect on economics

11.3.1

Dairy example

The computer program, RUMNUT, was used in Chapter 13, Section 13.2.1, to generate milk production responses when a dairy herd was supplemented with either good-quality silage or lower-quality silage. All other components of the diet were kept constant. Table 11.7 gives a summary of the results. Depending on the stage of lactation, milk production increased by 2.7 to 3.3 kg/day when the higher-quality silage was used as a supplement compared to lower-quality silage.

This example demonstrates that milk production can be increased by moderate improvement in silage quality. If milk is valued at 30¢/L (equivalent to 30.9¢/kg), the value of the additional milk produced from each tonne (DM) of the higher quality silage is about $85.

Work in the UK examined financial performance of 2,000 farms to judge the relationship between margins and silage quality and quantity. Margins per cow and per hectare increased as quality of silage increased (see Table 11.8).

Table 11.8 clearly demonstrates that the farmers who made high-quality silage had the highest margin per hectare. In this study, delaying silage harvest was also associated with reduced silage quality. Chapter 13, Table 13.10, gives details of this work.

While there are dangers in extrapolating data from Britain to Australia, the principles are the same and they clearly demonstrate that it is more profitable to produce quality silage by harvesting early.

Table 11.7

Milk production response in early lactation dairy cows supplemented with silages at two levels of quality. Cows received 30 kg of silage/day (fresh weight).

Lower-quality silage supplement		Good-quality silage supplement		Additional milk production from high-quality silage*
ME (MJ/kg DM)	Crude protein (% DM)	ME (MJ/kg DM)	Crude protein (% DM)	(kg/day)
9.0	14	10.0	17	+2.7

* *Dietary and milk production data is provided in Chapter 13, Table 13.6.*

Table 11.8

Effect of quality of silage on margin per cow and per hectare based on British data for 1987-88.

Quality of silage (MJ/kg DM)	% of herds	Margin over feed and fertiliser £/cow	($A/cow)	£/ha	($A/ha)
9.0-9.5	2	600	(1,714)	1242	(3,549)
9.5-10.0	17	637	(1,820)	1407	(4,020)
10.0-10.5	54	656	(1,874)	1496	(4,274)
10.5-11.0	25	682	(1,949)	1575	(4,500)
>11.0	2	719	(2,054)	1712	(4,891)

Conversion at £1 = $A2.85

Source: Poole (1989)

11.3.2

Beef example

Table 11.9 shows the effect of harvest delays on silage quality and cattle production. Liveweight gain (kg/ha) and silage quality declined significantly when harvest was delayed.

When liveweight gain was valued at $1.50/kg there was an additional $674/ha worth of beef produced on the early-harvest pasture. Potential net gain could be even higher, given that per hectare costs of silage production are likely to be lower because there is less quantity to harvest. The higher-quality silage that can be produced from the early harvest could also result in higher cattle prices (¢/kg) with potential for a higher proportion of the cattle meeting premium market specifications.

As well as affecting weight gains, feeding the lower-quality, late-cut silage is likely to limit the final market options that a producer may have and reduce the price/kg received for the end product.

11.3.3

Quality and machinery capacity

As discussed in Chapters 4 to 6, the growth stage of the parent forage at harvest and minimising delays during harvest are very important in the production of quality silage. There is likely to be a trade-off when using smaller equipment. Machinery overhead costs will be lower, but because harvest is slower, less optimum quality silage will be made. This is called a timeliness cost.

As a rule of thumb, a one-week delay in harvest decreases quality by 0.25-0.6 MJ/kg DM. This can, in turn, drop dairy cow milk production by up to 1.5 kg/cow/day. Conversely, an increase of one percentage unit in the digestibility of silage can increase milk production in dairy cows by approximately 0.35 kg/day or an additional 45 g/day liveweight gain in beef cattle.

Table 11.9

Effect of time of cut on silage quality and cattle production on perennial ryegrass silage.

	Relative growth stage at harvest		
	Early	Medium	Late
Days from 1st cut	–	9	17
Silage digestibility (DOMD%)	71.3	67.2	64.2
Silage intake (kg DM/day)	7.2	7.0	6.7
Liveweight gain (kg/day)	0.92	0.78	0.6
Feed efficency (kg liveweight gain/t silage DM)	129	112	90
Total forage yield (t DM/ha/year)	12.9	12.8	13.5
Liveweight gain (kg/ha)	1,664	1,434	1,215
Break-even yield for equal liveweight gain/ha	–	14.9	18.5
$ value of gain @ $1.50/kg ($/ha)	$2,496	$2,151	$1,822
Additional value compared to late cut ($/ha)	$674	$329	–

Source: Adapted from Steen (1992)

11.3.4

Quality and contractors

The use of a contractor can also incur timeliness costs. A contractor is likely to be interested in taking on a lot of work to help pay for the equipment and reduce the overhead costs per hour. Weather delays or equipment failure may mean that a contractor will not complete all contracted work at the optimal time. However, the high costs of machinery ownership can make this risk worth taking.

There are ways to reduce risks of delay when using contractors:

- establish a long-term relationship with a contractor so that you are likely to be given some priority;
- if possible, choose a contractor who will place you at the start of their run;
- some local farmers may have machinery and be interested in some contract work to supplement the work they do on their own farms; this can be an advantage, especially if your farm is ready for forage conservation a little earlier than the farm where the machinery is from;
- consider offering some labour and machinery to help a nearby farmer/ contractor finish the work faster on their own farm and then be available for yours; and
- consider carrying out forage conservation on some portion of the farm earlier than normal. For example, an area could be set aside early for baled silage.

11.3.5

Effect of quality on feed costs per unit of energy

There is a temptation to delay harvesting silage to increase forage yield, and so increase throughput and reduce unit costs. But, is it really worth it? Contractors may charge less per tonne or bale if harvesting is delayed to increase the bulk. When the rate is on a wet basis, the drier material will be cheaper on a $/t DM basis. However, a feed can be cheaper on a DM basis, but dearer on an energy basis (see Table 11.10).

Although Feed 1 is considerably dearer than Feed 2 on a DM basis, Feed 1 is cheaper when MJ levels (MJ/t DM) are taken into account. This principle is highlighted in Chapter 14, Table 14.26.

If Feed 1 was a silage made early and Feed 2 made later, Feed 1 is also likely to have a higher protein level. If so, this energy cost comparison does not show the extra savings with Feed 1 by reducing the requirement for protein supplements, nor does it reflect the greater animal production achievable using the higher energy feed.

The effect of ME content (MJ/kg DM) on intake should be noted. At low ME levels, DM intake is reduced and production potential is lessened because animals cannot achieve reasonable DM intakes.

In some situations, fibre or protein may be the limiting factor. For example, in Western Australia grain is often the cheapest source of energy on a ¢/MJ basis but silage still forms part of the diet because it provides the fibre missing from a grain ration. The cheapest protein or fibre source can be calculated in a similar way to that used for energy in Table 11.10.

Table 11.10

Comparing costs of two feeds on a DM basis and a per MJ basis.

	Feed 1	Feed 2
Cost of feed ($/t DM)	$120	$95
MJ/kg DM	11	8.0
MJ/t DM	11,000	8,000
Cost of feed per MJ	1.09¢/MJ	1.19¢/MJ

11.3.6

Effect of time and length of closure

The pasture management benefits of forage conservation are discussed in Chapter 3. However, Table 11.11 clearly demonstrates the economic benefits of making silage early.

Although less silage is made with an early harvest, it is of higher digestibility and there is additional high-quality regrowth compared to a situation where silage is made at a later date. The total DM production from the pasture is also higher.

The milk, beef and sheep production benefits of harvesting at an early growth stage are discussed in Chapter 13, Section 13.2.1; Chapter 14, Section 14.2.1, and Chapter 15, Section 15.2.1, respectively.

However, in areas with a high chance of weather damage or poor wilting conditions early in the silage-making season, the high risk may limit this option.

Plate 11.6

Maize silage offers a large bulk of forage, with high energy but low protein content. Per hectare costs of growing maize are considerable.

Photographer: K. Kerr

Table 11.11

Effect of closure time and harvest time after closure on silage yield and total pasture production. Results from perennial ryegrass/ white clover pasture, Ellinbank, Victoria.

Source: Rogers and Robinson (1981)

Closure length	Silage yield (kg DM/ha)	DM digestibility (%)	Forage yield (kg DM/ha) Yield 23 Sep to closure	Regrowth from cutting to 16 Dec	Total to 16 Dec
Early closure 23 September:					
Silage made 4 wks later	2,435	73.5	0	4,129	6,564
Silage made 6 wks later	3,373	71.6	0	1,949	5,322
Late closure 13 October:					
Silage made 4 wks later	1,625	69.2	1,826	806	4,257
Silage made 6 wks later	2,000	66.1	1,940	400	4,340

Section 11.4

Valuing a silage crop

11.4.1

Valuing maize silage from the maize grower's point of view

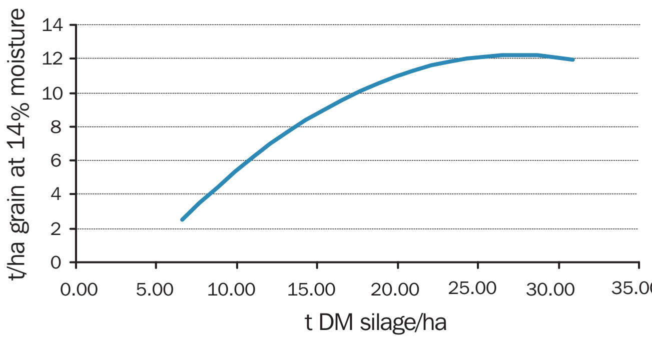
An increasing number of producers are choosing to buy maize silage from a nearby farm in an effort to decrease feed costs and increase feed supply without buying extra land. From the maize grower's point of view, the return from the silage crop should at least equal the return from the grain crop, or an alternative use of the land, after taking into account differences in harvesting and other costs of the two options. The example at right uses the following rules of thumb:

- The relationship between grain yield and silage yield has been taken from US information (see Figure 11.2). For maize crops, final grain yield at 14% moisture is approximately 55% of the DM yield of silage.
- The positives in making silage – having a clean paddock, getting the money early and having a paddock available earlier for another enterprise – is balanced out by the negative of losing most of the organic matter from the paddock.

The break-even price is the minimum price required for silage to match the returns expected from taking the maize crop through to grain harvest.

Figure 11.2

Relation between maize forage yield and grain yield.



Source: Adapted from Lauer (1999)

Calculating the break-even price (maize grower's view)

To calculate the break-even price for silage from the maize grower's point of view use the formulae:

Tonnes of grain equivalent =
Estimated wet yield of silage (t) x DM % of silage x grain as a % of DM (or read from graph in Figure 11.2)

Value of grain =
tonnes of grain equivalent x (grain price – grain harvest cost)

Harvest cost of silage =
estimated wet yield of silage (t) x harvest costs borne by grain farmer

Break-even price silage \$/t wet =
(value of grain + harvest cost of silage) ÷ estimated wet yield

Example:

Estimated wet yield = 60 t/ha

DM% = 35% (DM yield = 21 t)

Estimated grain yield at 14% moisture (from Figure 11.2) =11.3 t

Maize price = \$160 on farm

Grain harvest cost = \$18/t

Harvest cost borne by farmer = \$12/t wet for harvest and cartage.

(Harvest costs may be borne by the buyer. If so, the harvest cost borne by the farmer will be zero.)

If the grain option is chosen, the value of the organic matter in the crop residue (stover) is assumed to be equal to the cost of having the land tied up for longer plus the cost of slashing the stubble.

Calculations:

Tonnes of grain equivalent = 11.3 t

Value of grain = 11.3 x (160-18) = \$1,605

Harvest cost of silage = 60 x 12 = \$720

Break-even price silage (\$/t wet) = (1,605 + 720) ÷ 60 = \$38.75

Based on the assumptions listed, the grain farmer would have to receive at least \$38.75 for every tonne of silage (35%DM) delivered to the pit to make it a better proposition than grain.

11.4.2

Valuing maize silage from the buyer's point of view

The maximum that a buyer should pay for silage is based on the feed value compared to the cheapest alternative feed source. Maize silage may be the preferred option for a number of reasons besides supplying energy. For example, silage may be sought for fibre or in the situation where cattle are grazing high protein pasture, access to maize silage may help balance the nitrogen in the diet. In situations where factors other than energy are important, the supplementary feed, which you are comparing it to, should have similar attributes. For the comparison to be accurate, it may have to be made to a mix of feedstuffs.

The maximum price payable (the maize buyer's view)

The following formulae are used to work out the maximum price payable:

Tonnes of silage required to match a tonne of alternative (TSR) =

$$\frac{\text{MJ/t wet of alternative (allowing for losses)}}{\text{MJ/t wet of silage (allowing for losses)}}$$

Maximum price to pay (MP) =

$$\frac{\text{Price per tonne fed alternative}}{\text{TSR}} - \text{cost of feeding silage}$$

Example:

Best alternative = barley

MJ/kg DM barley = 12

DM barley = 90%

Feedout losses for barley 3% – or 97% fed
(Feedot losses include spillage losses in processing, transport or feed left by cows)

MJ/kg DM silage = 10.5

DM = 35%

Additional losses in silage (storage and feedout) 10% – or 90% fed

Cost of barley ($160 on farm + $15/t to feed and process) = $175

Cost of feeding silage = $12/t wet

Calculations:

MJ/tonne barley = 12 x 1,000 kg x 0.90 x 0.97= 10,476 MJ

MJ/tonne fed silage = 10.5 x 1,000kg x 0.35 x 0.90 = 3,307 MJ

Tonnes of wet silage required to match 1 t of barley (TSR) = 10,476 ÷ 3,307 = 3.17 t

Maximum price = ($175 ÷ 3.17) - $12 = $43.20

The maximum value that the farmer should pay in this case is calculated at $43.20. The final price would be negotiable and in this case if the grain farmer and the dairy farmer had done their calculations, the final price should fall between $38.75 (from the previous page) and $43.20/t.

In some circumstances the maximum the purchaser is prepared to pay is less than the minimum the farmer is prepared to accept. In this case, the farmer would let their crop go through to grain and the potential purchaser would choose the alternative feed.

11.4.3

Valuing a pasture for silage from the forage owner's point of view

A method of valuing standing feed is as follows:

The pasture could be compared to the value of the hay that could be made minus the value of any additional grazing from regrowth. The value of any regrowth is important because it is likely to be very palatable and is capable of producing high liveweight gain or milk production.

The following estimates are required:

- estimated quantity of silage likely, in bales or tonnes;
- estimated quantity of hay that could be made, in bales or tonnes;
- estimated on-farm value of the hay;
- estimated costs of making the silage;
- estimated value of the additional grazing. (As a guide good quality feed will produce 0.13 to 0.14 kg liveweight gain per kg of DM. A spring pasture is likely to produce around 1 tonne of good quality feed between silage making and the time when it could have been harvested as hay. If there were alternative pastures that could be grazed, the appropriate value to include would be an estimate of the additional value of meat or milk produced because of the higher weight gains achieved.)

The value of pasture for silage (the grower's view)

The formulae to make the calculation are:

Net value of hay =
quantity of hay made on farm x on-farm value of hay – cost of hay making.

Break-even value of silage =

$$\frac{\text{net value of hay - value of additional grazing + silage-making costs}}{\text{quantity of silage.}}$$

Example:

Size of paddock = 10 ha

Estimated quantity of silage = 35 t DM

Estimated quantity of hay = 42 t DM

Estimated on-farm value of hay = $110/t

Estimated costs of making hay = $1,800

Estimated cost of making silage = $0 (costs born by purchaser)

Value of additional grazing to the owner of the paddock = $1,000

Calculations:

Net value of hay = (42 x 110) - $1,800 = $2,820

Break-even value of silage = ($2,820 – $1,000 + $0) ÷ 35
= $1,820 ÷ 35 = $52/t DM.

That is, the owner of the feed would need to be paid at least $52/t DM, otherwise it would be better to leave it for hay.

If a per bale rate is required, you must know the number of bales to produce a tonne of DM. If each bale contains 200 kg of DM there are
1,000 ÷ 200 = 5 bales/t of DM.

The amount the purchaser would have to pay would be at least
$52 ÷ 5 = $10.40/bale.

If a paddock charge is desired, the amount required by the paddock owner would be at least $1,820.

11.4.4

Valuing a pasture for silage from a buyer's point of view

The value to the buyer is either the value of the cheapest alternative feed, or in a situation where there are no alternative feeds that are economic it is the value of the additional milk or meat less the costs.

Valuing pasture forage compared to the cheapest alternative feed (buyer's view)

The following estimates are required:

- value of the alternative feed per tonne DM, including feeding costs. A mix may be required to supply levels of protein and energy.
- the harvesting, transport and feedout cost per tonne of the silage.

Example:

Value of alternative feed is barley at $190/t DM on farm

Feeding costs is an additional $15/t = $205/tDM. (The additional protein in the silage is surplus to requirements in this case and a protein additive is not costed into the mix)

The harvesting, transport and feedout cost of silage is $110/t DM

The maximum the purchaser could pay in this case is $95/t DM (i.e. $205 – $110).

In this situation, the $95 value to the potential purchaser is well above the $52 (from previous page) required by the feed owner, so there is plenty of room for negotiation.

Valuing pasture forage where there are no alternative feeds

The estimates required to make this calculation are:

- expected extra production from using the silage;
- net value of that extra production;
- harvesting, transport and feedout cost of the silage.

Example:

The meat produced from each tonne DM of silage is estimated to be 135 kg.

The 35 tonne of silage is estimated to produce an additional 4,725 kg (i.e. 35 t x 135 kg/t) of meat, with a net value of $1.40/kg. Value of meat = $6,615 (i.e. $4,725 x 1.40)

Cost of making, harvesting, transporting and feeding the silage is $110/t DM.

Total cost is 35 x $110 = $3,850

Net gain = $6,615 – $3,850 = $2,765

The maximum price that could be paid is less than $2,765 or $79/t DM (i.e. $2,765 ÷ 35).

In this example, the break-even price is greater than $52 (from Section 11.4.3) required by the fodder owner, so an agreement can be negotiated.

Section 11.5

The *Forage Systems Model* – a costing analysis of forage conservation systems

This *Forage Systems Model* is a decision aid tool to help evaluate alternatives.

To access a copy of this model and to download the software go to <www.topfodder.com.au> on the Internet and follow the menu options: 'Silage Resources' and 'Decision Making Tools' . The model requires Excel 97, or later, to run and has been designed to lead the user through a series of worksheets.

From time to time an updated version of this software will be placed on the web. A check at the web address will reveal the version number.

The model uses a partial budget approach, which means that it only considers the effect of changes. It requires present production information as well as projections of production that will result from the intended change. The additional net income expected and the return on additional capital resulting from change is calculated on the analysis worksheet.

If projected returns on additional capital are inadequate, then it is pointless in proceeding further. If however, returns are attractive, it may be worthwhile following up with income and costs projections in a cash flow budget to assess the cash flow consequences of making a change.

The model is divided into a number of inter-related worksheets. Once you have entered all the necessary information on one sheet, click onto the next worksheet at the top of the screen to proceed.

Relevant data is automatically transferred between worksheets. If you need to change data already entered, go back to the relevant sheet, make the change and proceed.

First, enter data about the present situation. If it is going to take, for example, two years for the proposed system under consideration to get to full production, the figures for the present situation should be the projections of where the present system would be in two years' time. The model worksheets are as follows:

Present system

Crop Information: Details of the fodder production levels from the present system on an area basis.

Hours & Costs: Details of machinery hours spent on fodder conservation in each area and details of hourly running costs to determine the variable costs of machinery.

Overhead Costs: Calculations of machinery and labour costs.

Income: Milk and/or stock sales and prices are estimated and estimated net income is calculated.

Proposed system

An identical set of worksheets have to be filled in to get a picture of the proposed system.

Analysis

The Analysis worksheet contains a summary of the additional income and costs expected as a result of a system change, as well as an economic analysis.

It is recommended that a feed budgeting model is used in conjunction with the *Forage Systems Model* to ensure that feed cost and cow number estimates are achievable. There are a number of feed budgeting products available, or in development, that may have more information on pasture growth rates for a particular locality. Your adviser will be able to recommend the most suitable feed budgeting model for your area.

Section 11.6

Recommended procedure to evaluate a new forage conservation system

It is recommended that the following steps are carried out to properly evaluate whether a change in fodder production is warranted. Below is a summary of the steps required to accurately evaluate any proposed silage system or changes to an existing system:

1. A feed budget detailing production and consumption of the present pastures and fodder supplies should be undertaken. A similar feed budget should be prepared for the proposed situation.
2. Check the present budget to ensure it approximates what is currently happening on the farm. If there are significant differences an effort must be made to get it right. If the base production level is out, how can any projection possibly be accurate?
3. Detail the machinery and other resources required for the proposed situation.
4. Decide which equipment can be sold and what equipment has to be purchased. The cost of silage bunkers should be included here.
5. Estimate the changes in costs and income that occur as a result of the change. Costs include depreciation and interest costs, forage crop and pasture costs, animal costs and marketing costs.
6. Calculate the net returns (additional income less changes in costs).
7. Prepare a partial budget that calculates percentage return on the extra capital.
8. Decide if the return is attractive enough.
9. If return is attractive, prepare a cash flow budget to detail the adoption of the change.
10. If the cash flow budget looks acceptable, adopt the change.

The *Forage Systems Model* (see Section 11.5) is set up to take you through these steps.

Section 11.7

Appendices

11.A1

Maize pit silage example costs – dryland system

Calendar of operations

Operation	Month	Machinery hrs/ha	Machinery Cost $/hour	Machinery Total $/ha	Inputs Rate/ha	Inputs Cost $	Inputs Total $/ha	Total Cost $/ha
Slash	Oct	0.42	20.70	8.69				8.69
Cultivate – chisel	Oct	0.58	18.45	10.70				10.70
Cultivate – scarifier	Oct	0.42	16.60	6.97				6.97
Sow with planter	Nov	0.29	24.87	7.21				7.21
Seed	Nov	with above			20 kg	5.00	100.00	100.00
Fertiliser – Grower 11	Nov	with above			300 kg	0.56	168.00	168.00
Insecticide	Nov	with above			2.50 L	18.50	46.25	46.25
Herbicide – Primextra	Nov	0.10	18.20	1.82	5.30 L	9.85	52.21	54.03
Side dress urea	Dec	0.10	15.20	1.52	360 kg	0.44 kg	158.40	159.92
Inter-row cultivate	Dec	0.42	16.60	6.97				6.97
Harvest – contract	Apr		45.00 /t DM			(18 t DM)		810.00

Variable cost summary

Ground preparation and seed	141
Fertiliser	328
Herbicide	54
Insecticide	46
Irrigation	0
Harvest – contract	810
Levies	0
Total variable costs $/ha:	**1,379**
Cost $/t DM = $1,379 ÷ 18 = $76.60	

Note: cartage costs, pit costs and feedout costs not included.

11.A2

*Costing forage conservation systems**

As examples of costings of fodder conservation systems, three separate systems have been considered. These are:

- round bale hay;
- silage made in a pit with self-feeding or mechanised feeding; and
- round bale silage wrapped in plastic.

The round bale hay and silage systems have been considered on an owner/operator basis or with some or all of the operations done by contractors.

Assumptions

In costing these systems, the following assumptions have been made:

- 3.7 t hay/ha, 10 bales hay/ha, 9 bales silage/ha
- 150 t hay (85% DM); 127.5 t of DM
- 364 t wilted double-chopped pit silage (35% DM); 127.5 t of DM
- 255 t wilted round bale silage (50% DM); 127.5 t of DM
- area cut for fodder – 40.5 ha
- bales (1.5 m diam x 1.2 m wide) weigh 370 kg as hay and 700 kg as wilted silage
- density of wilted pit silage 700 kg/m^3

Losses assumed (at harvest, ensiling & feedout)

Hay 15%, round bale silage 8%, self-feeding pit silage 20%, mechanically fed pit silage 8%

MJ of final product

Hay 8.3 MJ/kg DM

Round bale and pit silage mechanically fed 10.5 MJ/kg DM

Pit silage – self-feeding 10.0 MJ/kg DM

** Adapted from Valentine and Cochrane (1996)*

Machinery costs	$
Tractors:	
40 kW	50,000
50 kW	65,000
70 kW	85,000
Disc mower	12,000
Rotary rake	12,000
Round baler	35,000
Front-end loader	12,000
Round bale feeder	9,000
Double-chop forage harvester	22,000
Hay trailer	6,000
Silage trailer	3,000
Silage feedout trailer	25,000
Hay shed cost	
8,500 conventional bales (405 round)	20,000
Silage pit cost	
Excavation costs – (two pits) each 260 m^3 (10.5 m x 2.5 m) i.e. to excavate a total of 260 m^3 and heap soil along sides to double capacity. Total cost	850
Labour cost	15/hr
Annual overheads	
Machinery	
Depreciation	10% of new price
Interest	6% of new price
Insurance/housing	1% of new price
Storage	
Depreciation (over 30 yrs)	3.3%
Interest	6%

Tractor running costs	$
40 kW	
Fuel (10.7 L/hr @ 45¢/L after rebates)	4.82
Oil & filters (15% of fuel)	0.72
Repairs & maintenance (3% of 50,000 per 1,000 hrs)	1.50
Tyres & batteries (4% of 50,000 per 1,000 hrs)	2.00
Total	**9.04/hr**
50 kW	
Fuel (12.1 L/hr)	5.45
Oil & filters	0.82
Repairs & maintenance (3% of 65,000 per 1,000 hrs)	1.94
Tyres & batteries (4% of 65,000 per 1,000 hrs)	2.60
Total	**10.81**
70 kW	
Fuel (16.0 L/hr)	7.20
Oil & filters	1.08
Repairs & maintenance (3% of 85,000 per 1000 hrs)	2.55
Tyres & batteries (4% of 85,000 per 1000 hrs)	3.40
Total	**14.23**
Repairs and maintenance on non-powered machinery 5% of capital cost per 1,000 hours	

ROUND BALE HAY (OWNER/OPERATOR)	
Machinery	**$**
Tractor (50 kW) (20% usage x $65,000)	13,000
Mower	12,000
Rake	12,000
Round baler	35,000
Front-end loader (40% usage x $12,000)	4,800
Trailer	6,000
Round bale feeder	9,000
Total	**91,800**
Annual overheads	
Machinery (17% x 91,800)	15,606
Storage (9.3% x 20,000)	1,860
Total	**17,466**
Operating costs (50 kW tractor)	
Mowing (0.54 hr/ha x 10.81 hr x 40.5 ha)	236
Raking (0.63 hr/ha x 10.81 hr x 40.5 ha)	276
Baling (0.45 hr/ha x 10.81 hr x 40.5 ha)	197
Carting (0.42 hr/ha x 10.81 hr x 40.5 ha)	184
Feeding (3 hr/ha x 10.81 hr x 40.5 ha)	1,314
Total	**2,207**
Labour	
5.04 hr/ha x $15/hr x 40.5 ha	**3,062**
Twine	
50 ¢/bale x 405 bales	**203**
Repairs & maintenance on non-powered machinery	
Mowing (5% x 12,000 x 40.5 x 0.54 hr/ha) ÷ 1,000	13
Raking (5% x 12,000 x 40.5 x 0.63hr/ha) ÷ 1,000	15
Baling (5% x 35,000 x 40.5 x 0.45 hr/ha) ÷ 1,000	32
Carting (5% x 6,000 x 40.5 x 0.42 hr/ha) ÷ 1,000	5
Feeding (5% x (13,800)* x 40.5 x 3 hr/ha) ÷ 1,000	84
Total	**149**
Summary	
Total cost	**23,087**
Cost/t of hay = 23,087 ÷ 150	154
Cost/tDM = 23,087 ÷ 127.5	181
Cost /t DM consumed allowing 15% losses	213
Cost ¢/MJ consumed @ 8.3 MJ/kg DM = 21,300 ÷ 8,300	2.57
* Front-end loader + Round bale feeder	

ROUND BALE HAY (CONTRACT BALING)

Machinery cost	$55,500
(18% usage of 50 kW tractor, baler not required)	

Annual overheads	$
Machinery (17% x 55,500)	9,435
Storage (9.3% x 20,000)	1,860
Total	**11,295**

Operating costs (50 kW tractor)	
Mowing	236
Raking	276
Carting	184
Feeding	1,314
Total	**2,010**

Labour	
4.59 hr/ha x $15/hr x 40.5	**2,788**

Repairs & maintenance on non-powered machinery	
Mowing	13
Raking	15
Carting	5
Feeding	84
Total	**117**

Contract baling	
405 bales x $11/bale	**4,455**

Summary	
Total cost	**20,665**
Cost/t of hay = 20,665 ÷ 150	138
Cost/t DM = 20,665 ÷ 127.5	162
Cost/t DM consumed (15% losses)	191
Cost ¢/MJ consumed @ 8.3 MJ/kg DM	2.3

ROUND BALE HAY (CONTRACT MAKING)

Machinery cost	$28,250
(13% usage of 50 kW tractor, mower, rake & baler not required)	

Annual overheads	$
Machinery (17% x 28,250)	4,803
Storage (9.3% x 20,000)	1,860
Total	**6,663**

Operating costs (50 kW tractor)	
Carting	184
Feeding	1,314
Total	**1,498**

Labour	
3.42 hr/ha x $15/hr x 40.5 ha	**2,077**

Repairs & maintenance on non-powered machinery	
Carting	5
Feeding	84
Total	**89**

Contract mowing raking	
Mowing (40.5 ha x $44/ha)	1,782
Raking (40.5 ha x $31/ha)	1,256
Baling (405 bales x $11/bale)	4,455
Total	**7,493**

Summary	
Total cost	**17,820**
Cost/t of hay = 17,820 ÷ 150	118.80
Cost/t DM = 17,820 ÷ 127.5	139.76
Cost/t DM consumed (15% losses)	164.43
Cost ¢/MJ consumed @ 8.3 MJ/kg	1.98

PIT SILAGE – SELF FEEDING (OWNER/OPERATOR)

Machinery	$
Tractor (70 kW) (20% usage x $85,000)	17,000
Tractor (40 kW) (10% usage x $50,000)	5,000
Mower	12,000
Rake	12,000
Forage harvester	22,000
Trailer (x 2)	6,000
Total	74,000

Annual overheads	
Machinery (17% x 74,000)	12,580
Storage (9.3% x 850)	79
Total	**12,659**

Operating costs (40 kW tractors)	
Mowing (0.54 hr/ha x 9.04 hr x 40.5 ha)	198
Raking (0.63 hr/ha x 9.04 hr x 40.5 ha)	231
Carting (0.5 hr/ha x 9.04 hr x 40.5 ha)	183
Forage harvesting (70 kW tractor) (0.52 hr/ha x 14.23/hr x 40.5 ha)	300
Total	**912**

Labour	
2.19 hr/ha x $15/hr x 40.5 ha	**1,330**

Plastic	
21 m long x 6 m wide x 200 cm ($100) x 2 pits	**200**

Hire tractor with front-end loader	
(for pit maintenance) $50/hr x 30 hrs (including driver)	**1,500**

Aggregate	
Base of pit (10.5 m x 10 m x 0.3 m) x 2 pits = 63m³	
Feeding pad (10 m x 6 m x 0.3 m) = 18 m³	
Total = 49.5 m³ x 2 pits = 99 m³ x $20 ÷ 1.8 m³/t = 1,100	
Annual cost = 1,100 x 10%/year = 110	**110**

Repairs & maintenance on non-powered machinery	
Mowing (5% x $12,000 x 40.5 x 0.54 hr/ha) ÷ 1,000	13
Raking (5% x $12,000 x 40.5 x 0.63 hr/ha) ÷ 1,000	15
Carting (5% x $6,000 x 40.5 x 0.50 hr/ha) ÷ 1,000	6
Forage (5% x 22000 x 40.5 x 0.52 hr/ha) ÷ 1,000	23
Total	**57**

Summary	
Total cost	**16,768**
Cost/t silage = 16,768 ÷ 364	46.07
Cost/t DM = 16,768 ÷ 127.5	131.52
Cost/t DM consumed (25% losses)	173.35
Cost/MJ consumed @ 10MJ/kg DM	1.75

PIT SILAGE – MECHANICAL FEEDING

Mechanical feeding requires the purchase of a front-end loader with a silage grab and a 9 m³ silage feedout wagon which will replace one silage trailer.

Additional costs	$
Machinery overheads	
17% x $(25,000 + 12,000 – 3,000) = 17% of $34,000	5,780
Operating costs (70 kW tractor)	
Loading & feeding out silage (1hr x ha x $14.23/hr x 40.5ha)	576
Labour	
1 hr x ha x $15 x 40.5 ha	608
Repairs & maintenance on non-powered machinery	
Feeding (5% x $3400 x 1hr/ha x 40.5ha) ÷ 1,000	69
Total additional costs	**7,033**
Subtract annual cost of aggregate for feed pad which is no longer required	-72

Summary	
Total additional net cost	**6,961**
Cost/t silage = (16,768 + 6,961) ÷364	65.19
Cost/t DM = 23,729 ÷ 127.5	186.11
Cost/t DM consumed (15% losses)	218.95
Cost ¢/MJ consumed @ 10.5 MJ/kg DM	2.09

Note: This system is expensive because there is not enough throughput to justify the high capital outlays. A larger quantity of silage made per year would reduce costs.

PLASTIC WRAPPED ROUND BALE SILAGE (CONTRACT WRAPPING)

Machinery	$
Tractor (50 kW) (25% usage x $65,000)	16,250
Tractor (40 kW) (10% usage x $50,000)	5,000
Mower	12,000
Rake	12,000
Round baler	35,000
Front-end loader (50% usage x $12,000)	6,000
Trailer	6,000
Round bale feeder	9,000
Total	101,250
Annual overheads	
Machinery (17% x 101,250)	**17,213**
Operating costs (50 kW tractors)	
Mowing (0.54 hr/ha x 10.81 hr x 40.5ha)	236
Raking (0.63 hr/ha x 10.81 hr x 40.5ha)	276
Baling (0.74 hr/ha x 10.81 hr x 40.5ha)	324
Carting & wrapping (0.5 hr/ha x 10.81 hr x 40.5 ha)	219
Feeding (4 hr/ha x 10.81/hr x 40.5 ha)	1,752
Total	**2,807**
Labour	
(6.41 hr/ha x $15/hr x 40.5 ha)	**3,894**
Twine	
(50¢/bale x 365 bales)	**183**
Plastic	
($6/bale x 365 bales)	**2,190**
Repairs & maintenance on non-powered machinery	
Mowing (5% x 12,000 x 40.5 x 0.5 hr/ha) ÷1,000	12
Raking (5% x 12,000 x 40.5 x 0.63 hr/ha) ÷ 1,000	15
Baling (5% x 35,000 x 40.5 x 0.50 hr/ha) ÷ 1,000	35
Carting (5% x 6,000 x 40.5 x 0.50 hr/ha) ÷ 1,000	6
Feeding (5% x (15,000)* x 40.5 x 2.5hr/ha) ÷ 1,000 * Front-end loader + Round bale feeder	76
Total	**144**
Hire wrapping machine	
$3/bale x 364 bales	**1,095**
Summary	
Total cost	**27,526**
Cost/t silage = 27,526 ÷ 255	107.95
Cost/t DM = 27,526 ÷ 127.5	215.89
Cost/t DM consumed (8% losses)	234.66
Cost ¢/MJ consumed @ 10.5 MJ/kg DM	2.23

ROUND BALE SILAGE (CONTRACT BALING)

Machinery	
Cost $58,000	
(20% usage of 50 kW tractor; 40 kW tractor and baler not required)	
Annual overheads	**$**
Machinery (17% x 58000)	**9,860**
Operating costs (50 kW tractor)	
Mowing	236
Raking	276
Carting	219
Feeding	1,752
Total	**2,483**
Labour	
(5.67 hr/ha x $15/hr x 40.5 ha)	**3,445**
Repairs & maintenance on non-powered machinery	
Mowing	12
Raking	15
Carting	6
Feeding	76
Total	**109**
Contract baling & wrapping	
(365 bales x $20/bale)	**7,300**
Summary	
Total cost	**23,197**
Cost/t silage = 23,197 ÷ 255	90.97
Cost/t DM = 23,197 ÷ 127.5	181.93
Cost/t DM consumed (8% losses)	197.75
Cost ¢/MJ consumed @ 10.5 MJ/kg DM	1.88

ROUND BALE SILAGE (CONTRACT MAKING)	
Machinery	
Cost $30,750 (15% usage of 50 kW tractor; mower, rake, baler and 40 kW tractor not required)	
Annual overheads	**$**
Machinery (17% x 30,750)	**5,228**
Operating costs	
Carting (0.5 hr/ha x 10.82 hr x 40.5 ha)	219
Feeding (4 hr/ha x 10.82/hr x 40.5 ha)	1,752
Total	**1,971**
Labour	
(4.5 hr/ha x $15/hr x 40.5 ha)	**2,734**
Repairs & maintenance on non-powered machinery	
Carting	6
Feeding	76
Total	**82**
Contract mowing, raking & baling	
Mowing (40.5 ha x $44/ha)	1,782
Raking (40.5 ha x $31/ha)	1,256
Baling & wrapping ($20/bale x 365 bales)	7,300
Total	**10,338**
Summary	
Total cost	**20,353**
Cost/t silage = 20,353 ÷ 255	79.82
Cost/t DM = 20,353 ÷ 127.5	159.63
Cost/t DM consumed (8% losses)	173.51
Cost/MJ consumed @ 10.5 MJ/kg DM	1.65

Conclusion

There are obviously large differences between the systems in costs per tonne of DM conserved. However, the relative costs can be altered significantly by changes in scale and assumptions of work rates, the feed quality and the losses involved. These costings provide a template of how to use your own figures to arrive at a cost.

11.A3

Contacts for contract rates

Australian Fodder Industry Association <http:// www.afia.org.au>

South Gippsland Ag Contractors Association

West Gippsland Fodder and General Contractors Association Inc.

Victorian Western Districts Agricultural Contractors Association

Big Square Baling Contractor's Association (WA)

Western Australian rates can be found on the web at <http://budget.farmline.com.au>

A broad guide to contract rates is often published in the major rural newspapers. The *Weekly Times* publishes rates at the beginning of each silage-making season.