Mileage from silage: latest advances with silage for beef cattle

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Introduction

In cool temperate areas of the world, ensilage is a well-established means of conserving forage for times of the year when forage growth is less than requirements. It is also an excellent means of preserving forage when it is produced in excess to requirement. Compared to hay, silage is less weather dependent and is better suited to large-scale, mechanised production. Thus, even in good drying situations, silage can have advantages over hay. Unlike hay, silage is a dynamic ecosystem that has to be cajoled into producing high-quality feed. Thus, management before, during, and after ensiling the crop can have a major impact on the intake of and performance from silage by cattle. This paper will highlight the important management decisions that will increase the likelihood of successful silage making.

Why silage in Australia?

Weather and growing conditions in Australia are very different to those in Canada. Under Canadian conditions, cattle have to be given stored feed for 5 months of the year or longer, often while indoors. Added to this, weather conditions in early summer (June) are often wet. This is the time of year when forage quality is at its best and the time of year to start silage making if two or three harvests are to be taken during the short growing season of 4 to 5 months. As a consequence of these constraints, there is an ongoing trend away from hay and in favour of silage as the conserved forage of choice. The continuing specialisation and increase in farm size also favours silage over hay.

In Australia, the driving forces behind making silage are perhaps less powerful; nevertheless, there are some clear reasons why silage might be considered an option in many circumstances. These include:

- Seasonality of forage production.
- Size of farm enterprise (mechanisation).
- As an aid to pasture management (harvesting of surplus forage).

As in Canada, one of the major determinants driving the use of silage in rations is the relative price of silage versus other feeds. In seasons where grain is cheap, silage can become a relatively expensive feed source. However, when grain is expensive, then silage can be competitively priced (Table 1). A property with an established silage conservation system has one more option at its disposal when it comes to juggling the vagaries of climate and market trends. Generally, the more options a farmer has, the more robust the operation will be.

Table 1. Relative feed costs in Canada.

Feed	$/tonne DM	¢/ kg gain
Potato waste	10-20	8-10
Pasture	30-60	30-60
Silage	100-150	45-70
Barley	100-300	80-160
Hay	80-250	100-300

Making quality silage

Silage is the product of a biologically active process called fermentation, which takes place in moist crops in the absence of oxygen. It can be envisaged as an ecosystem, the dynamics of which are largely controlled by factors within the silo itself. Thus, the success of ensiling depends in large measure on what goes into the silo and how successfully the silo is isolated from the outside world. Outside factors, such as air and heat (or cold), can upset the dynamics within the silo. In biochemical terms, fermentation is the conversion of sugars found in the crop into acids. This conversion is done by silage microbes under anaerobic conditions (in the absence of oxygen). The acids produced by the microbes then reduce the pH and prevent the crop from spoiling. Because silage fermentation is an active, dynamic process it can easily be disrupted. The success to good silage making depends on an understanding of the process and the ability to manipulate the crucial components. These are moisture (measured as dry matter (DM)), substrate (the food for microbes), and finally, the microbes themselves.

When crops are ensiled, they have upon their surfaces a wide range of epiphytic micro-organisms, a small fraction of which are of value in silage fermentation. These are the lactic acid bacteria. Under optimum conditions of DM and substrate availability, they produce lactic acid to preserve the crop.

The wetter the silage, the more biological activity of all kinds there will be (Figures 1 and 2). This is not necessarily a good thing. Managing the ensilage process means creating an environment that favours desirable microbes over undesirable microbes.

However, if a silage is too dry, there will not be enough moisture to support sufficient microbial growth to reduce the pH and preserve the crop. Optimum crop DM content is between 25% and 60%, depending on the type of crop and storage system (Figure 3). This is achieved by wilting prior to ensiling. However, in very dry, hot conditions, the standing crop may be dry enough. Maize is also ensiled without wilting. Good management in the field can be used to accelerate

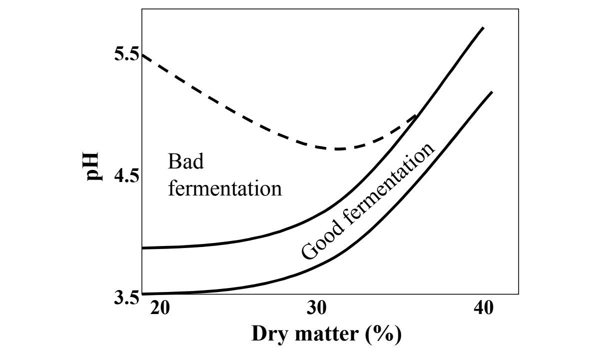

Figure 1. Moisture and silage fermentation. The drier the silage, the higher the pH can be for successful preservation.

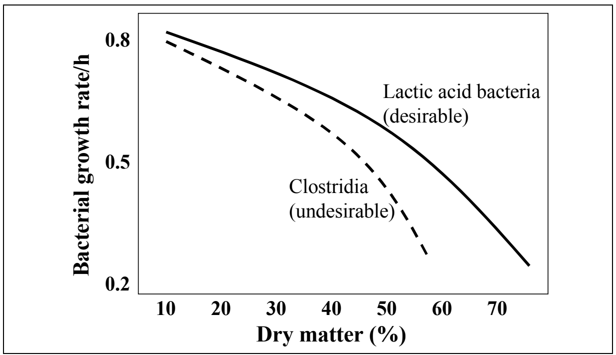

Figure 2. Moisture and microbial growth. The undesirable microbes are more disadvantaged by high DM than are the desirable microbes.

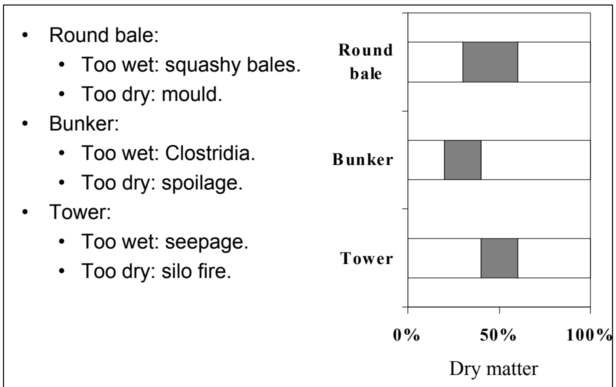

Figure 3. Optimum dry matters for silage in bales, bunkers, or towers (silos).

(spreading, tedding, or conditioning) or slow down (rowing up) drying to help ensure the optimum dry matter.

Silage micro-organisms need a supply of soluble carbohydrate or sugars. Most crops contain between 3% and 10% of their DM as sugar. These sugars are used up by the microbes to produce acids. Since the role of acids is to reduce pH, strong acids, like lactic acid, are needed. Because the sugars are a finite resource, efficient use is paramount. Manipulating DM content will help to ensure that the best producers of lactic acid, the homolactic bacteria, will predominate in the microflora and that lactic acid production will be maximised.

Silage making can be managed successfully by:

- Wilting, which optimises the dry matter and concentrates the substrate.
- Airtight silos, which promote rapid fermentation.
- Additives, such as inoculants, that add more lactic acid bacteria.

No matter what the crop or system of ensiling used, the single most important determinant for making successful silage is management of these factors at ensiling. While various aids to silage making are available, these do not substitute for good management practices.

Silage systems in beef enterprises

Today there are two quite distinct silage systems: round-bale silage and chopped silage. Both have a number of variants.

Round-bale silage is well-suited to small-scale production, has low labour requirements, and has lower capital requirements than most chopped silage systems. Thus, it works well for smaller operations or as a component of forage conservation on larger operations. This latter area is probably where its use could be exploited in pastoral Australia. The strength of round-bale silage is its versatility, particularly when used in combination with other forage storage systems and as part of a pasture management program. The system is well-suited to harvesting small parcels of crop whenever these are surplus to requirement, such as surplus pasture. Feed-out can be as simple as rolling out the bale in the paddock or dumping the bale into round-bale feeders. No specialised feeding system is needed. Round-bale silage is less adaptable where large areas are to be harvested or where a purpose-built feeding system is used.

Chopped silage is better suited to larger-scale operations because of its speed of harvest and the higher capital costs. It is a less flexible system and therefore not as easily integrated with a grazing system. Storage options range from a heap on the ground, through a variety of bunker (clamp) designs, all the way up to expensive tower silos. Generally, as the cost increases, management becomes less critical in ensuring successful silage making.

Precision-chopped silage systems work best under intensive forage production combined with a dedicated feed-storage and feeding system. In Canada, this would be common in beef herds of over 100 cows, in grower operations, and in the finishing feedlot. This is because the Canadian climate dictates some investment in a feeding system (yards, barns, and bunks), a constraint not necessarily found in Australia. Nevertheless, silage could be an integral part of feedlot operations, where large quantities of consistent-quality forage are required. Under these conditions, such crops as ryegrass, lucerne, maize, and whole-crop cereals make excellent silage. The key to success is speed of operation, which ensures optimum digestibility of the crop and rapid filling of large silos, thus ensuring minimum spoilage and heating.

Feeding value of silage

The feeding value of silage is dependent upon the nutritive value of the crop at ensiling and the amount of silage an animal will eat. While the nutritive value of the crop is dependent upon the crop species and the maturity at which it is harvested, voluntary intake is also modified by the process of ensiling. Historically, it was felt that cattle ate less forage when it was ensiled, as compared with the fresh or dried product. This is no longer necessarily true, and excellent intakes can be achieved with silage using modern management methods (Figure 4).

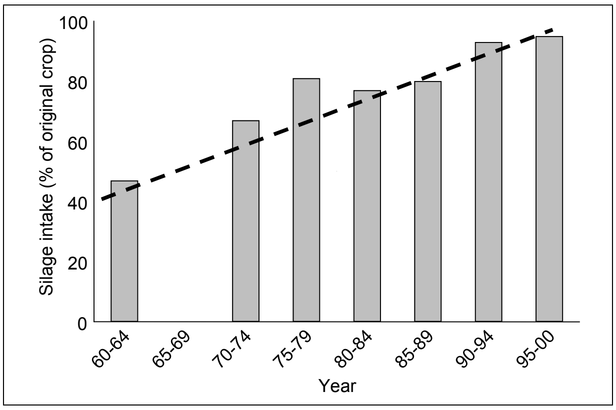

Figure 4. Data from 40 years of silage trials comparing the intake of silage with that of the unensiled crop.

Research has repeatedly shown that the best performance of growing and fattening cattle from all-silage diets is around 1 kg/day with an intake of about 2% to 2.5% of body weight. Better performance than this is rare and can usually be linked to compensatory gain or the feeding of an exceptionally immature forage (higher than 65% digestibility). Unlike pasture, where the animal does the harvesting, it is more cost-effective to allow the crop to bulk up before putting machinery through. Of course, as it bulks up, it also matures and digestibility declines. In North America, optimum digestibility is usually between 60% and 65%. In Europe, where the price differential between grain and silage tends to favour silage, then higher-digestibility silage is made (65% to 70%).

All-silage diets have a role when grain is expensive, but feeding a silage-grain combination is often more cost-effective. Not only does the grain increase the overall nutrient content of the diet, it also increases the utilisation of the energy in the silage. This is due to a better balance of nutrients in the rumen.

Silage usually contains enough crude protein for all classes of beef cattle. However, during ensiling the solubility of protein increases; and often silage protein is used poorly in the rumen. The protein is highly degradable. Thus, much research has shown a response in growth when supplemental protein is fed with silage.

With protein concentrates being so expensive to purchase, we have done considerable research trying to improve the protein value of silage (Charmley, 2001). We now know that such processes as rapid wilting and/or acidification in the silo can markedly improve protein value. Good silage management therefore plays a critical role, not only in preserving the crop, but also in preserving the feeding value of the protein (Table 2).

Table 2. Improving protein quality in silage improves animal performance.

Characteristic	Level of additive		
	Nil	Medium	High
DM of silage (%)	34	32	34
Crude protein (% DM)	18	18	18
Protein insolubility (%)	41	55	60
DM intake (% liveweight)	3.1	2.9	3.0
Liveweight gain (kg/day)	0.74	0.86	0.87

Source: Charmley (2001).

The feeding value of silage should be matched to the livestock it is intended for. Silage can be too good for certain classes of beef cattle. Beef cows, for example, can meet all their energy and protein requirements from silage of about 55% digestibility and 11% protein. When making silage for these cattle, go for quantity, not quality; and harvest when the crop is more mature, but there is more of it in the field (Figure 5). A rapidly growing 300-kg steer needs 65% digestibility silage and more protein. Here you need younger, leafier crops. Finally, a finishing 2-year-old needs lots of energy and very little protein; maize, barley, or sorghum silage fits the bill here. By knowing the needs of the cattle and the value of your forages and by having a flexible harvesting and storage system, silage gives you the ability to fine tune and hence maximise utilisation of the feed resources on your property.

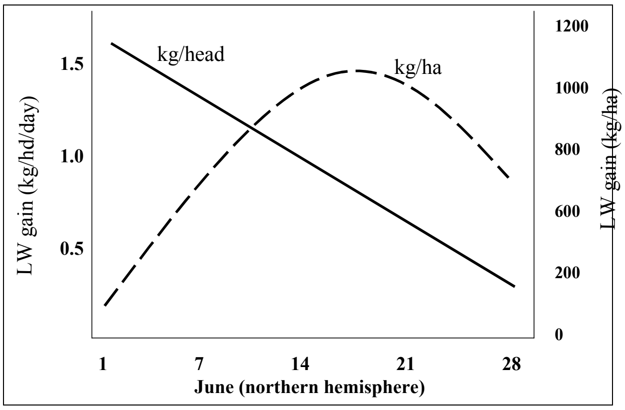

Figure 5. Delaying harvest increases gain per hectare at the expense of gain per animal; but after 21 June (Canadian conditions), it becomes a lose-lose situation.

As with pasture, quality silage needs quality management. It is a relatively capital-expensive forage, which makes good management all the more worthwhile. While silage is unlikely to ever become a dominant feed resource in southeastern Australia, it undoubtedly has a wider role to play in the future.

Reference

Charmley, E. (2001). Towards improved silage quality: a review. *Canadian J. Animal Science* 81:157–168.