4.3 Feed storage and wastage

Some basic rules apply to the handling of feedstuffs and the management of the feeding system to minimise wastage and spillage. Of particular concern is the management of odours, contaminated runoff, unwanted degradable solids and refuse associated with the storage and handling of feedstuffs.

Types of feedstuffs

The reliance on pasture grown on dairy farms continues in many districts, but farmers are increasingly relying on both supplementary fodder grown off-farm and introduced rations. Types of feed are many and varied, and their use depends on cost, availability access and preference. Feeds include:

- straw
- hay
- silage
- grain
- pellets
- food by-products; e.g. brewer's grain, palm kernels, marc (the residue left after grape pressing), citrus pulp, chocolate powder
- time-expired or unsaleable food products, such as stale bread, fruit and vegetables, bakery products and confectionery seconds.

Transporting feedstuffs

Dairy farmers need to consider transport routes for by-products to minimise complaints, particularly in cities and towns. The occasional spill from an overturned truck can cause much angst as well as odour. Loose products must be covered to avoid spillage. In some jurisdictions, curfews limit site access. Sites receiving loads must allow ample room for vehicle movement: at least 5 m around bunkers or silos for safe access.

Feed management systems

The major factors dictating system selection are capital and operating costs, the type and availability of feed, and the ability to cope with a range of feeds at the same facility. Harris (1984) provides relatively unbiased coverage. The variety of storage and feeding systems is immense; systems include:

- trench silos
- clamp silos or bunkers
- vacuum stack ensilage
- round bale ensilage
- towers (e.g. Harvestore brand)
- silage baggers (e.g. Silopress brand).

Sites set aside for these systems need allow room for the movement of vehicles.

All of these feeding systems, with their associated watering systems and stock congregation, have the potential to accumulate manure, thereby increasing the risk of surface water and groundwater contamination. Additionally, there can be significant loss of feed with all of them, further increasing the risk of emissions. The facility manager will need to regularly collect spills, product residues, waste plastic and runoff for reuse or disposal. This practice will not only reduce the risks of surface water or groundwater contamination and odour emissions, but also keep the feed quality high.

Although much is known about the use of manure and effluent from feedlots and the control of atmospheric emissions, details are lacking for sites where animals congregate in unconfined conditions, and feed losses are rarely quantified. The following practices will aid feed management:

- Calculate how much feed will be transported and stored and how often it will be received. Take note of the moisture content.
- Rotate portable facilities.
- Harrow or harvest accumulated manure.
- Feed out at a site where odour emissions, runoff and groundwater ingress are least likely to affect the environment beyond the farm.
- Ensure that access lanes can be cleaned by a back scraper or front-end loader by providing a well-designed surface.

Information on the fodder requirement for dairy cattle, particularly during drought, is widely available (Hinton (1994), Leaver and Grainger (1989), Long (1992), (Freer 2007)). It covers trail feeding, broadcasting, feeders, dispensers for urea–molasses supplements and feedlots.

Feedstuff spills and losses

During the mixing of rations and feeding out, losses will occur. All storage and feeding-out losses contribute to odour, greenhouse gas emissions and solid wastes. Although these feeds do not carry stock or human pathogens, they can contain nutrients and have a high BOD.

Control of feed losses also reduces the pest burden on a farm and potential disease vectors.

Storing silage

Ensilation is an anaerobic fermentation process used to conserve fodder for an extended period with minimal loss of quality. The reliance on anaerobic conditions contributes to the potential risk of odour propagation and biogas generation. Minimising contamination with earth, old silage and water can reduce the risk of emissions during silage making, storage and withdrawal for feeding out. Rapid resealing, covering exposed bales and reducing leaks will keep the period of exposure to the air to a minimum. Suitable conditions can be created by compacting and storing the raw material in a sealed vessel. Any oxygen not removed by compacting is rapidly removed by bacteria.

Sealing prevents CO_2 from escaping and the re-entry of air during storage. Any contact between the silage and air will result in decayed, inedible and sometimes toxic material. Aerobic degradation increases dry material losses and reduces nutritional value. This material then becomes waste.

The quality of fermentation depends on the types of bacteria present in the sealed vessel. Effective fermentation requires the presence of lactic acid bacteria and the absence of clostridial bacteria. Clostridia are inefficient at converting plant sugars to acids, and produce silage of poor nutritional value. Lactic acid bacteria are very efficient at converting plant sugars to acids, and produce the non-odorous fermentation associated with good silage.

When acidity builds up in the vessel, microbial activity diminishes and the plant material is preserved. The removal of residues, spilt silage, old plastic and runoff can reduce the amount of clostridia in the silage, thereby increasing its value.

Improving the effectiveness of ensilation will result in:

- less odour in general
- less noxious odour
- less unusable product
- less liquid, because clostridia rely on wet conditions, whereas lactic acid bacteria rely on plant sap.

Wastage of silage through spills and exposure has both economic and environmental costs.

Losses associated with silage storage and feeding out

Effluent from silage stores can emanate from the product or rainfall ingress, and rainfall from surfaces containing spilt feed can add to the effluent burden. This effluent can have a very high BOD: concentrations over 10 000 $mg \cdot L^{-1}$ have been registered. Regular cleaning of surfaces and separation of entrained solids will reduce treatment requirements and odour emissions. All contaminated runoff around the feed storage and works areas should be contained and reused.

Leachate is associated with the type of storage system: the higher the stockpile or silo, the greater the pressure and the potential for seepage (Ernst *et al.* 1990). Seepage is associated with loss of quality. Table 1 indicates the losses associated with the content of dry matter (Ernst *et al.* 1990).

Table 1. Dry matter content and effluent.

Dry-matter content (%)	Dry-matter loss in effluent (%)
10	12
33	0

Spoilage is associated with edges, usually through poor sealing and air penetration. Rainfall penetration and soil contamination can result in poor uniformity of product. Rats, mice and other vermin and poor quality control during handling can expose silage to air and thus spoilage.

The amount of feeding-out loss depends on the method used: feeding in troughs or on a concrete pad or mat results in less loss than on the ground, along fence-lines and laneways or by self-feeding from the bunker, owing to less soiling and trampling by livestock. The activity of bacteria, yeasts and moulds is accelerated when silage is exposed to air; these microorganisms degrade the silage, producing unpalatable and potentially toxic feed of low nutritional value. Exposure of silage during feeding out is a major cause of deterioration by secondary fermentation. Removal at the rate of 10 to 30 cm per day minimises losses, and a range of new ensiling techniques reduce exposure time and surface area (Park and Stronge 2005). Good ensilation achieves better fodder conservation than hay (Table 2) (Ernst *et al.* (1990).

Table 2. Typical dry matter losses (%) in silage and hay making.

Location	Silage (wilted 36 h)		Hay (6 days' drying)
	Round bale (wrapped)	Bunker	
Field	<5	<5	22
Storage	<5	10	5
Feeding out	3	3	1
Total	13	18	28

Silage leachate characteristics

The pollution potential or BOD of silage leachate is significant; the strength of the leachate from 1 t of silage with a moisture content of about 23% is equal to that of 18 000 L of sewage. The amount of leachate produced by maize silage depends on the moisture content of the crop and on the degree of consolidation.

Silage leachate has a low pH, is very corrosive to metal and will damage concrete. Any metal coming into contact should have a protective surface finish.

Grain and food-processing by-products

The dairy industry is drawing on an increasing diversity of grains and food-processing by-products, some of which liberate odours as a result of anaerobic decomposition and extended storage. Storage in a dry sheltered environment (in a shed or under a canopy) will avoid rainfall ingress, dust propagation and microbial decomposition. Grains and food-processing by-products should be stored on protected surfaces such as concrete pads or polyethylene or rubber mats, rather than in direct contact with soil. Drainage is essential. Feeding-out machinery should be dedicated to the purpose and not come into in contact with soil. Mycotoxins can contaminate some feedstuffs, so breathing apparatus is recommended. If contamination is found, the provenance of feeds should be traceable; soil shipped with fodder can introduce microbial pathogens to a farm.

Marc feeding and the use of by-products from the fruit and vegetable processing industries are contributing to the successful exploitation of waste from one industry to the benefit of another, but can aid the transfer of pests and diseases. Regulations control the transport of grapes and vines to avoid the spread of phylloxera; others govern the movement of fruit to avoid the export of fruit fly.

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