



Summary report: Feed wastage study

Why was this study undertaken?

Feed wastage must be minimised if feed conversion efficiency and feed cost per unit of milk are to be optimised.

Feed losses on farm occur during:

1. Delivery and storage of feeds
2. Mixing of diets
3. Feed-out of diets to cows

While feed losses during feed-out can be the most significant for many feeds on farm, they have not been well documented, with few studies having been done in Australia or overseas. In fact, even the methods used to quantify feed wastage rates associated with different feed-out methods have not been well described.

To address this situation, Dairy Australia's Grains2Milk program has undertaken a study of feed wastage rates on 50 commercial dairy farms in the states of QLD, NSW, Vic and SA which use a range of different feed-out methods. This work was undertaken for Grains2Milk by SBScibus.

Aims and methods

The objectives of the study were to:

- Review the literature on feed wastage during storage, mixing/delivery and feed-out periods
- Quantify the amount of feed wasted during the feed-out period in 50 dairy farms with different feed-out methods
- Semi-quantitatively assess the feed wastage during the storage, mixing, loading and delivery of feed on 6 selected farms
- Use the results to develop practical information and recommendations for farmers and service providers.

Farms involved in the study spanned the six different feed-out methods described by Grains2Milk as used on Australian dairy farms:

1. Temporary, relocatable - bare area (ground or ring feeder)
2. Feed allocated on pastures in the paddock
3. Semi-permanent
4. Permanent, basic but functional
5. Permanent, minimal waste, maximum control
6. Grain feeding in the dairy parlour

Descriptions of these six feed-out methods are provided in **Appendix 1**.

On each farm a number of parameters were measured, including: number of cows, farm location and environmental conditions, ration components, total amount of feed offered, feed refusal and wastage, length of feed trough for feed-out methods 3, 4 and 5, area of paddock available to the cows for feed-out methods 1 and 2.

The assessment of feed wastage was conducted under dry conditions to enable us to accurately quantify the feed wastage. (Feed wastage under wet conditions can only be quantified accurately under controlled, experimental conditions).

The amount of uneaten / leftover feed was classified as 'refusal' and 'wastage':

- Refusal - is the amount of feed that remains in the feed troughs, on pasture and on bare ground, and does not get consumed by cows after a certain period of time following the feed-out. The refusal may or may not be eaten at a later stage.
- Wastage - is the amount of feeds that are contaminated with urine or faeces and soil or spread out around the feed-out area and will not be eaten by cows at a later stage.

With feed-out methods 4 and 5, feed refusals can be collected and fed to other cattle. While it is possible that cattle can return to refusals with other feed-out methods eg. silage left on pasture, it should be assumed that this becomes waste after a certain period of access.

Key findings on wastage during feed-out

The table below summarises the feed refusal and wastage rates measured with the 6 feed-out methods.

Table 1. Summary of amount of feed refusal and wastage (% DM & % as fed) with 6 feed-out methods used on Australian dairy farms

	Refusal (% DM/As fed)	Wastage (% DM/As fed)	Total estimated feed wastage (% DM/As fed)
1- Temporary, relocatable – bare area & ring feeder	4.93 ± 4.56 (0.0-13.7)	12.99 ± 10.42 (1.55-27.66)	17.92 ± 12.70 (3.27-35.44)
2- Feed allocated on pastures in the paddock	3.35 ± 3.14 (0.0-8.23)	5.52 ± 5.75 (0.0-14.24)	8.88 ± 7.89 (0.92-22.33)
3- Semi-permanent	1.97 ± 2.05 (0.0-5.37)	3.55 ± 5.49 (0.08-16.06)	5.52 ± 5.58 (0.08-16.49)
4- Permanent, basic but functional	2.56 ± 2.77 (0.03-6.18)	2.03 ± 2.00 (0.18-4.89)	2.03 ± 2.00 (0.18-4.89)
5- Permanent, minimal waste, maximum control	5.92 ± 8.05 (0.0-22.12)	1.79 ± 2.02 (0.0-5.58)	1.79 ± 2.02 (0.0-5.58)
6- Grain feeding in the dairy parlour (rotary and herringbone)	6.25 ± 11.15 (0.057-38.63)	0.28 ± 0.33 (0.013-0.951)	0.28 ± 0.33 (0.013-0.951)

Note -

- The main figures are the mean and standard deviation. Figures in brackets are the range
- These measurements were taken in dry conditions, and may not reflect the full range of wastage that might occur under wet conditions.

Key findings from the study on wastage during feed-out were:

- Feed wastage after feed-out (feeding losses) includes losses due to trampling, leaf shatter, chemical and physical deterioration, faecal and urinary contamination and refusal. The amount and costs of these losses may be influenced by a number of factors such as feeding methods, intervals between feedings, amount fed at a time, climatic conditions, number of cattle being fed, access of cattle to feed, competition for the feed and forage quality.
- There is substantial variation in the amount of feed refusal and wastage between and within feed-out methods on Australian dairy farms.
- Feed wastage was significantly greater with feed-out methods 1 and 2 (ie. those feed-out methods with less structure and investment) than other feed-out methods. Note - Feed-out method 1 (Temporary, relocatable – bare area & ring feeder) is the most common feed-out method used on Australian dairy farms.
- Much lower wastage rates were observed with feed-out methods 3, 4 and 5. Wastage was very low with feed-out method 5 (Permanent, minimal waste, maximum control system).
- There was substantial variability in the amount of feed wasted with feed-out method 3 (semi-permanent) – this can be attributed to the many different feed troughs and feed-out surfaces used on these basic facilities.
- Within all feed-out systems, some farmers achieved very low wastage. These variations may reflect variations in farm management within a particular system eg. feed-out procedure, feed bunk management, forage quality, operator skill etc.
- There was no significant association between the amount of feed offered per cow and amount of feed wastage per cow across all feed-out methods.
- The wastage rate was significantly associated with the NDF and ME content of the diet fed across feed-out methods 1 to 5.
- Wastage of grain tended to be greater than that of pellets in the dairy bail on some farms. However, feed wastage rates observed in the dairy across all farms were very modest.
- Substantial variability in grain allocation per cow per milking was observed in some herringbone dairies on each side, from one end to the other.

Examples of feed wastage from the study are provided in **Appendix 2**.

Guidelines for measuring feed refusal and wastage on farm are provided in **Appendix 3**.

Strategies to minimise waste during feed-out

These are some suggested strategies to minimise waste during feed-out:

i) Feed ingredients / rations

- Pay close attention to chop length when cutting hay / silage – if it is too long, the cows will sort through it and waste more
- Protect hay and silage well during storage to minimise dry matter and quality losses
- Offer cows fresh, palatable, high quality feed at all times. Discard any spoiled / mouldy feed ingredients
- If feeding a Partial Mixed Ration (PMR) using a mixer wagon:
 - Take care to ensure the mix is not under or over processed. Follow the manufacturer's instructions.
 - Use ration conditioners such as water, molasses, oil to reduce fines, sorting of feed and rejection or wastage of feed

ii) Feeding infrastructure design

- Hay feeder design affects the amount of hay wastage. Feeders that encourage cows to keep their heads in the feeder opening, reach for feed, and not back away easily and drop hay on the ground are preferred. Eg. a slatted bar design on a ring feeder which forces cows to rotate their heads when entering or leaving the feeder.
- If using troughs:
 - Ensure you provide adequate space for the number of cows (reco: 75cm / cow)
 - Aim for a trough height that allows cows to eat with their head in their natural grazing position - about 10-15 cm above the ground. This position also helps cows produce more saliva to help buffer their rumen
 - Ensure trough surfaces are smooth to avoid build-up of waste feed, moulds, odours and are easy to clean
 - Consider concrete aprons around troughs to prevent mud and slush reducing feed palatability

iii) Feeding management

- Offer cows the right amount of feed at the right time of the day - don't overfill troughs
- Sequence feeds carefully during each 24 hour period
- Clean feed-out surfaces regularly
- If feeding out on pasture, avoid long pastures
- Consider cows social order (aggressive versus less dominant cows)
- Adapt to the prevailing weather conditions

Hay losses during storage

While silage losses during storage are well described in the TopFodder 'Successful Silage' manual, information on hay losses during storage is not as widely available. The literature review done as part of the study uncovered some very interesting information on hay losses during storage:

Storing hay outside, unprotected and on the ground has the greatest potential for dry matter, digestible dry matter and nutrient losses due to spoilage and weather deterioration. Losses can be halved by using good coverings, and reduced by about two-thirds by storing the hay indoors in a shed.

Several factors affect hay losses during storage, including

- Moisture levels at baling (relates to mould development and heating)
- Bale density – at least 49 kg DM/m² is recommended
- Storage time X Rainfall and humidity. Note - weathering effect is greatest in the outer 15cm layer, which constitutes 1/3 the weight of a round bale
- Wicking effect - up to 50% of losses occur at the bale / soil interface
- Bale placement (Best is end-to-end, spaced 45-90 cm apart, North-South)

Further information from the study on feed wastage during delivery and storage of feeds, and mixing of diets will be provided by Grains2Milk in due course.

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Appendix 1

Six feed-out methods used by Australian dairy farmers

Six main feed-out methods used by Australian dairy farmers have been defined by Dairy Australia's Grains2Milk program and SBScibus for the purpose of the feed wastage study as follows:

1. Temporary, relocatable (bare area)

Definition: Forages or partially mixed rations are fed out on the **bare ground** in the paddock or under **an electric fence line, in hay rings or old tractor tyres**, using existing equipment at the site (eg. a tractor and bucket or silage cart, etc.). In this system the cows are **not grazing** the paddock where the feed is fed out and the paddock is commonly referred to as a **sacrifice paddock**. There are no prepared surfaces for the feed-out area. In this system the feed-out facility can be readily located to other sites around the farm; this may be required in special circumstances when the paddock becomes muddy following a heavy rainfall event.

2. Feed allocated on pastures in the paddock

Definition: Forages or partially mixed rations are fed out into the paddock where the **cows are grazing**. The feed is usually fed out either straight on top of the pasture anywhere in the **paddock or under an electric fence line** using equipment commonly found on most dairy farms (most likely a tractor and bucket or silage cart).

3. Semi-permanent

Definition: **Forage mixes or more complex mixed rations** are fed out on a **semi-permanent feed-out** area with a compacted surface that uses low-cost troughs, such as conveyor belting, second-hand feed or water troughs or other materials. The equipment used for feed-out is usually a silage cart or mixing wagon.

4. Permanent, basic but functional

Definition: Complex **mixed rations** are fed out using a **purpose-built feed-out** facility with a compacted surface that has concrete feed troughs or a narrow cement strip under electric wires or cable to prevent cows trampling feed. A mixing wagon is usually used for mixing and feed-out.

5. Permanent, minimal waste, maximum control

Definition: Complex **mixed rations** prepared using a mixing wagon are fed out using a **purpose-built feed-out facility**, most likely with a cement surface for the cows and one or more feed alleys. This may be covered with a roof and may also incorporate a loafing area or cow stalls. **Headlocks or cabling** and even in some cases an electric wire are used to restraint the cows to prevent feed losses due to trampling.

6. Grain feeding in the dairy parlour

Definition: Supplementary grain or pellets are fed in the dairy during milking. This system is used in both conventional herringbone and rotary dairies. A wide variety of systems are found in dairies from some of the more advanced and costly where the feed allocation can be altered according to the manager's requirements. In some instances cows can be individually fed using one or more supplements, and the trough space is divided between cows using physical barriers, i.e. gates or a looped rail separating the cows' heads in the trough. To some more basic systems where only one supplement and/or amount can be fed to the cows and the trough area has no physical barriers separating the cows.

Appendix 2

Examples of feed wastage from the study

High amount of feed wastage (27%) (feed-out method 1):



Cattle fed cereal hay on pasture (feed-out method 2):



Minor feed refusal and wastage (4.4%) for cattle fed cereal hay on pasture (feed-out method 2):



Minor feed refusal and wastage (2.7%) for cattle fed lucerne hay on conveyer belting (feed-out method 3):



High feed refusal and wastage (18%) for cattle fed lucerne and cereal hay on pasture:



Very little feed refusal and feed wastage (1.3%) for cattle fed a PMR (feed-out method 5):



Cows wasting feed due to the design of troughs allowing cows to push feed over the side:



High feed refusal in a rotary dairy:



Appendix 3

Guidelines for measuring feed refusal and wastage on your own farm

These guidelines, developed as part of the Grains2Milk feed wastage study, are provided for use by farmers and advisers.

Feed-out method 1. Temporary, relocatable - bare area

Rations fed out on the bare ground:

1. Select a clean area along the feed-out line.
2. Place 4 tarpaulins (1 x 1 m) along the area on the ground where the feed-out is intended to take place.
3. Mark with spray-paint the corners of each of the tarpaulins and mark a straight line directly out from each tarpaulin, at least 4 meters distance (Figure A).
4. Feed out.
5. Weigh the amount of feed on top of each tarpaulin and place the feed back in the marked areas, without using the tarpaulins.
6. Allow the cows access to the feed
7. When the cows have finished, weigh the amount of feed left inside each of the 1x1 m areas. The amount of feed left over divided by the total amount fed in the 1x1 m area is feed refusal (%).
8. Collect the amount of feed left over in the areas on the ground directly out from each of the four 1m² areas. Collect feed spread at least a distance of 4 meters out from where the original feed was placed. This amount divided by the total amount fed in the 1x1 m area is feed wastage (%).
9. If there are areas heavily contaminated with faeces or urine, then select an appropriate area similar in size and which appears to have the same amount of feed wastage, to be used as a replacement measurement.

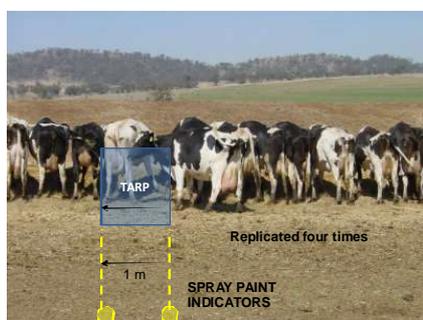


Figure A. Feeding on the bare ground.

Rations fed out in ring feeders on bare ground:

1. Select a clean area in the paddock to place the ring feeders(s)
2. Weigh the ration/feed placed in each ring feeder
3. Allow cows access to the feed
4. When the ring feeders would normally be replenished or when the cows don't have access to the feed again, the remaining feed inside the feeder is considered refusal and the feed spread around the area surrounding the feeder is considered wastage.
5. The amount of feed left over inside the feeder divided by the total amount fed out per feeder is feed refusal (%).
6. Collect the feed that is spread out at least 4 meters from the centre of the ring feeder. This amount divided by the total amount fed in the feeder is feed wastage (%).
7. If there are areas heavily contaminated with faeces or urine, then select an appropriate area similar in size and which appears to have the same amount of feed wastage, to be used as a replacement measurement.

Feed-out method 2. Feed allocated on pastures in the paddock

1. Follow the same procedures as system 1 (see Figure B for the same principle on pasture)
2. Preferable use a "Blow-Vac" machine to collect the residue as a proportion of fines (grains, leaves etc) falls in the between the pasture which makes it impossible to collect "by hand".



Figure B. Feeding on pastures.

Feed-out methods 3, 4 and 5 (Semi-permanent, Permanent, basic but functional and Permanent, minimal waste, maximum control)

1. Clean out any previous feed residues in the troughs or on the material used as a trough.
2. Place 4 tarpaulins (1 x 1m) in the troughs.
3. Mark with spray-paint the corners of each of the tarpaulins and mark a straight line directly out from each tarpaulin, at least 4 meters distance (Figure A and D).

4. Feed out.
5. Weigh the amount of feed on top of each tarpaulin and place the feed back in the marked areas, without using the tarpaulins.
6. Allow the cows access to the feed
7. When the cows have finished, weigh the amount of feed left inside each of the 1X1 m areas. The amount of feed left over divided by the total amount fed in the 1x1 m area is feed refusal (%).
8. Collect the amount of feed left over in the areas on the ground directly out from each of the four 1m² areas. Collect feed spread at least a distance of 4 meters out from where the original feed was placed. This amount divided by the total amount fed in the 1x1 m area is feed wastage (%).
9. If there are areas heavily contaminated with faeces or urine, then select an appropriate area similar in size and which appears to have the same amount of feed wastage, to be used as a replacement measurement.

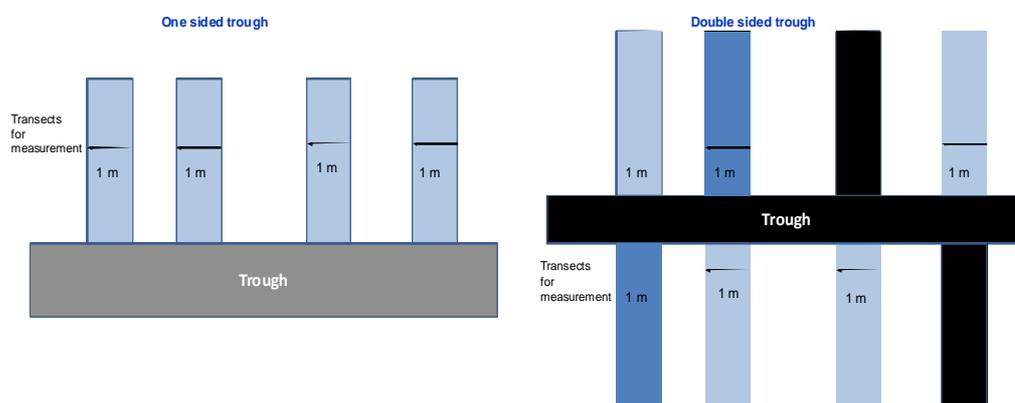


Figure C. Procedures for feeding system 3, 4 and 5.

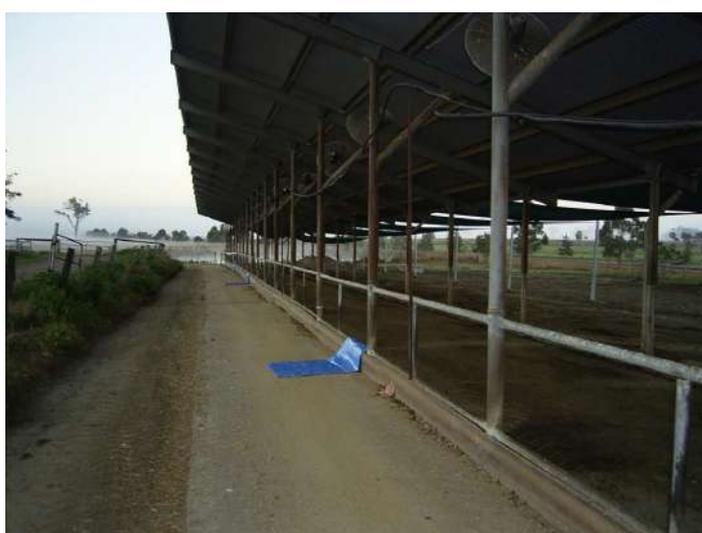


Figure D. Placing the tarpaulins before feed-out (one sided trough)

Feed-out method 6 (Grain feeding in the dairy parlour)

Herringbone dairy

1. Before milking clean out all troughs and remove any grain residue from the floor.
2. After the first row of milking (both sides of dairy), record the weight of grain left over in the troughs. This amount divided by the total amount of grain fed out during the first two rows is feed refusal %. Repeat this step half way during milking and at the end of milking and take an average of the measurements.
3. After the first row of milking (both sides of dairy), record the amount of grain on the dairy floor. This amount divided by the total amount of grain fed out during the first two rows is feed wastage %. Repeat this step half way during milking and at the end of milking and take an average of the measurements.

Rotary dairy

1. Before milking clean out all troughs and remove any grain residue from the floor.
2. Select 4 bays on the rotary and mark with tape or paint (use approximately every 10 bay).
3. After the first round of milking, record the weight of grain left over in each of the 4 bays. This amount divided by the total amount of grain fed per bay is feed refusal %. Repeat this step half way during milking and at the end of milking and take an average of the measurements.
4. After the first round of milking, record the weight of grain spilt on the floor under each of the 4 bays. This amount divided by the total amount of grain fed per bay is feed wastage %. Repeat this step half way during milking and at the end of milking and take an average of the measurements.

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