Feed Pads

DOWN UNDER

Tom Davison
Jeff Andrews
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Preface

Feed Pads Down Under is a photographic collection of ideas and designs for managers interested in feeding their cattle with more precision. This book has been a joint project between the Department of Primary Industries, Queensland, and Keenan Pty. Ltd., as both organisations saw the need for such a book with the growing interest amongst farmers whose feed systems integrate conserved forages, by-products, or bulk commodities, in combination with grazed pastures. The book comes out of many requests from farmers throughout the southern hemisphere requesting help with the design of feed pads, commodity bunkers, silage and molasses storage.

The drought of 1991-95 in northern Australia saw a rapid uptake in the use of silage, by-products, and commodities. For example, in Queensland in 1986, less than 3% of dairy farmers were using silage of any form in their feeding systems while in 1995, 35% of farms used silage in their feeding programme. In southern Australia most of the annual pasture yield is produced over the spring and early summer period. This uneven growth cycle necessitates, for many farms, forage conservation and the feeding back of home grown hay or silage in summer and autumn. Feed pads can maximise the utilisation of these home grown forages.

The wet winters encountered in southern Australia and New Zealand also mean that feed pads will become more common as managers realise the benefits of reducing damage to pastures and gaining more control of their rations to cows and heifers.

The lower cost of bulk commodities and protein meals or bulk grains bought at harvest allow a reduction in feed costs. The one off capital cost associated with feeding commodities and by-products such as molasses, whole cottonseed, brewers grains, citrus waste, pineapple pulp, potatoes, palm kernel expeller, fruit waste, and vegetable waste, is the need to store them on farms. A section in the book deals with how farmers around Australia store these products in bulk.

We have included dimensions and costs next to the photos as well as farm managers names and phone numbers. These people are willing to talk over their own design if it interests you.

Feed Pads Down Under is a practical book that draws on the experiences of the authors, collaborators, and farmers, as a means of assisting others interested in these systems of feeding.

Tom Davison and Jeff Andrews.
Great idea
this table service.

Not dirt
again?
Introduction

Many sections of the Australian and New Zealand dairy industries have pushed production per cow to a level which can not easily be obtained from pasture alone or even from pasture plus concentrates fed in the dairy.

Many dairy farms now feed some form of supplementary forage for all or part of the year. When such feeds are used regularly, some type of forage feeding facility or feed pad is often more convenient. However feed pads can congregate large numbers of animals on to small areas thus creating potential environmental, animal health and animal welfare problems.

Textbooks on dairy feed pad design for Australian, New Zealand, and southern hemisphere conditions still remain to be written. Much can be learned from the US and European industries, but not all can be applied directly because of different farming systems, cost and availability of materials, employment conditions, and labour rates.

Why have a feed pad?

Reduce feed wastage

Silage, hay, grain and byproducts are all expensive materials and it is common to waste up to 23% of such material when feeding along fence lines or straight onto a pasture. These materials can cost up to $180 per tonne dry matter so cows consuming 2 tonne of such dry matter per year would waste 460 kg per year or $83 per cow or $8300 for a 100 cow herd.

A good feed pad will reduce the wastage to less than 5% or under $1800 (Moran 1996). If the cows had eaten this wasted material, the 100 cows could have each produced 430 L per year extra milk (1.4 L/day), or conversely saved 36 tonnes of dry matter - enough to feed the herd for another 50 days.

Reduce mastitis, hoof and leg problems

Concentrating cows together for extended periods on poorly set-up feedpads usually leads to a build-up of manure mixed with mud. Such conditions are ideal for the growth of pathogenic bacteria and several mastitis pathogens (particularly Strep uberis) can be expected in large numbers. During extended periods of dry weather, the risk of infection seems low but during, and after, rain the infection risk is higher, particularly if the cows lounge in mud and manure. Standing in mud usually softens cows hooves leading to increases in foot-rot and associated problems, particularly if stones are present to cause bruising. Good feed pad design is aimed at minimising such problems.

Minimise heat loads

A prime reason for the construction of many covered feed pads in Australia will be to minimise heat stress. Davison et al (1996) have demonstrated the possible gains in feed intake, milk yield, milk composition and reproduction which can be obtained through minimising heat loads. Losses in milk yield of $10 000 to $40 000 are common in our hotter areas and larger herds with higher production per cow will lose the most by not protecting their cows.

Protect the environment

Feed pads congregate large numbers of animals on to small areas, creating potential environmental problems. Earth or gravel areas around feed troughs always contain large amounts of manure and are high-risk areas for pollution of both surface and ground water. Good feed pad design will contain all potential pollution sources and present an attractive appearance to help maintain the clean, green image of dairy products.
Feed pad systems

Low cost feed pads
$1 to $15 per cow

Feed pads in this category could include feeding out straight on the ground, along fence lines or roadways. Hollow logs, second-hand bath tubs or water troughs and used conveyor belting from the mining industry can all be used. While these systems may be cheap, they usually are associated with high wastage and thus hidden costs. Wet weather will turn feedpads on most natural surfaces into a quagmire. When the mud becomes contaminated with manure, environmental mastitis pathogens will appear in large numbers. Although the cost may rise to the higher end of this category, a compacted gravel base for such a system is a sound investment.

Bath tubs or old tractor tyres are good for tractor and bucket to feed out. Used conveyor belting on a compacted gravel base is probably the best of the low-cost systems for use with a feed-out wagon. A small depression can be left in the base to partially form the belt into a trough and the edges can be raised up further with star pickets, logs, or by tying the sides together.

Gravel surfaces can be made more hard wearing with products like Terra Firma - an acidic stabiliser. The product is sprayed on with a boom spray after the gravel is initially spread. Gravel and stabiliser are mixed with several passes of the grader after which the gravel is watered and compacted. The stabilised gravel has lasted well for several years on some feedpads, although in other situations, variable results were achieved.
Hollow logs have been used to feed cows in Australia for decades. The narrow profile means more width per cow has to be allowed and they are also hard to clean out.

Conveyor belting is 1.5 m wide and is cheap at around $10/m. If well supported it can be an effective feed pad, costing $4-5/cow.

These second hand water troughs are too narrow and shallow with considerable spillage of feed over the sides.
**Feed Pads DOWN UNDER**

---

**Jim Lawry**
Thomas Road  BINGEE  VIC  3571  
Phone: (03) 5436 8275

- **System type:** Feed pad
- **Year built:** 1995
- **Cow numbers:** 260
- **Cost:** $1 800 ($7/cow)

**Feed pad**
30 m long, and 3 m wide. Cement pad with compacted gravel area for cows placed on exit lane from the dairy.

**Cleaning system**
Dry scraped as required and manure stockpiled, and spread on paddocks by contractor.

**Comments**
Works well if not not too much feed on the pad. Two hot wires down the centre.

---

**Derek and Andrew Gilmour**
'Woodbury’ MS 422  
CLIFTON Q 4361  
Phone: (076) 964 168

- **System type:** Feed pad
- **Year built:** 1992
- **Cow numbers:** 140
- **Cost:** $2,000 ($14/cow)

**Feed pad**
100 m long, and 1 m wide. Height of nib wall is 450 mm. Conveyor belting was used in combination with split posts spaced 6 m apart with two strains of cable wire. The floor is of gravel with the pad facing north-south.

**Cleaning system**
Dry scraped once a year with the manure stockpiled and spread onto pasture.

**Comments**
Very happy with system.
Medium cost feed pads
$15 to $100 per cow

Feed pads in this category could include pre-cast concrete troughs as commonly used in beef feedlots. Such troughs are usually designed for one-sided feeding of high concentrate rations and often lack sufficient capacity for two-sided feeding of bulky forage rations. More elaborate conveyor belt systems with metal supports, a simple flat cement pad without any cover, and purpose-built precast concrete troughs for two-sided feeding all have been used.

Medium cost feedpads would usually have a concrete floor and are often planned with the view to covering with a roof later.

Orientation must be considered when planning such a pad and if flush cleaning is ever on the drawing books, the pad should fall at 2-3% in the longitudinal direction.

Cement-treated road base (CTB) can be a cheaper alternative than concrete. CTB is available at $18-20 per ton (4% cement) within 20 km of the source (e.g. - Boral or Pioneer Quarries) and, after compaction, has a bulk density of 2.2 tonnes per m$^3$. The CTB is spread over the site, watered and compacted leaving a surface almost as hard as concrete, although some loose stones may be present.

**Michael Smith and Shane Barry**

V. and A. Barry and Sons
(Contact Shane Barry)
50 Straud St
BULAHDELAH NSW 2433
Phone: (049) 974 262

System type: Feed pad
Year built: 1996
Cow no: 160
Cost: $6 000 ($38/cow)

**Feed trough**
60 m long, inside width of 1.2 m, inside height of 400 mm, outside height of 500 mm, and a wall thickness of 200 mm.
Cows have 3.5 m of concrete either side of trough. Pad faces east-west with a series of 100 mm pipes crossways under troughs to allow rainwater to be drained from the top side.

**Cleaning system**
Bobcat scrapes pad once a fortnight, stockpiled to spread onto pasture.

**Comments**
Would widen cow standing area to 4.5 m wide and would use formwork rather than Besser brick.
Feed Pad
70 m long, and 1.5 m wide concrete strip. Height of the nib wall is 300 mm on the feeding side. Facing north-south. Cows stand on a gravel pad under shade cloth.

Cleaning system
Dry scraped when required and the manure stockpiled.

Comments
Concrete feedpad is on the eastern side which allows cows to feed from one side only. Shade cloth is included in the system cost. Nib wall would be better at 400 mm to reduce spillage.

Shade
Shade cloth (65%) is 36 m log and 3.5 m wide. Supplied by: Darling Downs Tarpaulins (076) 342166.

Feed Trough
Precast 105 m long, and 900 mm inside width at the top, and 750 mm at the base. Inside height is 300 mm. Cows stand on a gravel base.

Cleaning system
The pad is dry scraped once a month or as required, and the manure stockpiled and spread onto the pasture.

Comments
Troughs were originally too low so were lifted and placed onto cement blocks 225 mm thick, they now sit 525 mm off of the ground. Troughs need to be wider to hold more feed. Used for Keenan TMR mix and green chop lucerne.
Feed trough
50 m long, 1.3 m inside width and 400 m minside height. Wall thickness is 150 mm. The pad faces east-west and the floor is 3 m of concrete on either side of the troughs.

Cleaning system
Dry scraped as required and manure is stockpiled and contract spread onto pastures.

Comments
Very good. Troughs have to be hand cleaned if any feed remains. Could have got away with a hot wire running down the centre of the troughs instead of steel bars (extra cost).

Feed pad
This feed pad made from compacted Scobie gravel is 300 m long and 10 m wide. The 300 mm high and 1 m wide feed trough is made from roadside barriers with a slope away from the trough to the channel. Gravel cost was $7 000.

This high limestone gravel, or Scobie gravel from northern Victoria is a cheap material ($12/m³) on which to build a feed pad or use in laneways. It can be spread, wet, and rolled, to provide an extremely hard surface for cattle to be fed on. However in wet weather it can become slippery and sand may need to be placed on top.
Grant and Glenys Currey
Currey Road
UPPER COOMERA Q 4209
Telephone: (07) 5573 1818

- System type: Feed pad
- Year built: 1995
- Cow no: 130 (room for 200)
- Cost: $8 500 ($43/cow)

Feed pad
60 m long and 8 m wide cement pad facing east-west on the exit from the dairy with a 2 m slope.

Feed trough
60 m long, with an inside width of 1 m and an inside height of 375 mm. Wall thickness is 125 mm.

John and Catherine Cowley
‘Lentara’
MS 765 ALLORA Q 4362
Phone: (076) 663 439

- System type: Feed pad
- Year built: 1994
- Cow numbers: 140
- Cost: $8 000 ($57/cow)

Feed pad
50 m long and 6 m wide, facing north-south.

Feed trough
50 m long with an inside width of 800 mm, a height of 600 mm, and a wall thickness of 100 mm.

Cleaning system
Dry scraped once a month and the manure stockpiled.

Comments
Troughs are placed 100 mm above standing position of the cows.
Feed pads DOWN UNDER

**Feed trough**
41 m in length and an inside width of 600 mm and inside height of 450 mm. The wall thickness is 75 mm. The floor is of gravel and the pad faces north-south.

**Cleaning system**
Dry scraped as required, with the manure stockpiled to spread onto pasture.

**Comments**
Stands up very well under wet conditions

---

Yvonne and Harry Barrell
Rosebrook Lane
MUSSWELLBROOK NSW 2333
Phone: (065) 433 904

- **System type:** Feed pad
- **Year built:** 1996
- **Cow numbers:** 100
- **Cost:** $6,000 ($60/cow)

---

**Feed shed**
40 m long, 11 m wide, and 3.7 m high. Facing north-south sloping to the east. The floor is half gravel, and half cement.

**Feed trough**
40 m long, and 600 mm width inside. Height inside is 350 mm and wall thickness is 50 mm.

**Cleaning system**
The shed is dry scraped when required, the manure stockpiled before being spread over pasture.

**Comments**
Feed troughs need to be wider to prevent spillage, and shed needs a second row of troughing. If I could do it again, I would put the posts for the shed in the troughs for easier cleaning.

---

Chris and Samantha Hughes
Cobby Pastoral MS 126
HARRISVILLE Q 4307
Phone: (07) 5464 6239

- **System type:** Feed shed
- **Year built:** 1996
- **Cow no:** 120
- **Cost:** $13,000 ($87/cow)
Feed pad
60 m long, 8 m wide, and the wires are 1 m high, and 1.5 m apart. The floor is cement, 100 mm in the centre and 138 mm on the outer edges, with a 20 mm fall to the outside. The pad is facing north-south.

Comments
Nylon tape is preferred to wire as it is flexible. The less number of posts, the easier it is to clean. Feed pad needs a roof. The pad was built to reduce losses of silage, hay and cottonseed during wet weather.

Kyabram Research Institute (Contact John Moran)
Kyabram VIC 3620
Phone: (03) 5852 0500

System type: Feed pad
Year built: 1988
Cow no: 160
Cost: $30/cow (1996 estimate)

Feed pad
50 m long, 5 m wide, 100 mm of fibre crete. Facing east-west, silage is fed on the exit lane from the dairy. Feeding space of 650 mm per cow has been allowed. Electric wires are 1.4 m apart and 1 m high. Longitudinal slope is 1 in 50.

Cleaning system
Scraped with a front-end loader.

Comments
Feed pad paid for in 2-3 years.
High cost feed pads
$100 per cow and above

High-cost feed pads are usually covered with a roof. The more economical pads have either one or two troughs while more expensive systems usually have a central feeding alley for the tractor and feed wagon. The most elaborate systems have bedding, without or without free-stalls, as used in the USA and Europe.

Figure 1. (a) Cross-section of single feed trough design with a skillion roof.

Figure 1. (b) Single feed trough showing floor plan and flushing system.
A simple covered feed pad with a single trough as shown in Figures 1 and 2 currently costs about $75 per m² which translates to about $320 per cow. You will note however in the following farm examples where many such shed costs are below $200/cow through the use of the owners time and labour, and the use of second-hand materials. A double trough pad (Figure 3) is around $300 per cow while feed pads with central feed wagon alleys (Figure 4) translate to about $440 per cow. A full free-stall barn to USA specifications costs about $700 per cow or more, in Australia.

Figure 2. Cross-section of single feed trough pad with a gable roof shed.
Figure 3 (a). Cross-section design for a double trough feed pad with cattle entry from both sides of troughs.

Allow 700 mm per cow in length. Lengthways fall 2-3% and 25 mm cross-ways fall away from the feed troughs. Feed wagon alleys 125 mm reinforced concrete. Roof to fall crossways at 1 (vertical) to 3 (horizontal).

Figure 3 (b). Floor plan showing double feed trough layout.

Storm water drainage directly to concrete (no gutters).
Figure 3 (c) Flood washing system for a feed pad with dual feed troughs.
Figure 4 (a). Central feed alley shed design.

Figure 4 (B). Central feed alley floor plan.

Allow 700 mm per cow in length. Lengthways fall 2-3% and 25 mm cross-ways fall away from the feed troughs. Feed wagon alleys 125 mm reinforced concrete. Roof to fall crossways at 1 (vertical) to 3 (horizontal). Feed wagon alley 100-150 mm higher than cow alley.
Figure 4 (c) Flood washing system for a feed pad with a central feed alley.
Feed shed
64.5 m long, 17 m wide, 4.3 m high at the eaves, 6.9 m at the apex. The shed is facing north-south, and the roof slope is 18° with a 500 mm vent. The floor is cement with a longitudinal slope of 3%. (See Figure 3)

Feed troughs
4 x 26.25 m long troughs, 1.2 m inside width and 400 mm inside height, with a wall thickness of 100 mm.

Cleaning system
Flood washed once a day with the wash going into two effluent ponds. Water from the second pond is used to wash the shed and irrigate pasture.
Len and Peter Bischoff  
Mt Lindsay Highway  
TAMROOKUM Q 4285  
Phone: (07) 5544 2296  

System type: Feed shed  
Year built: 1992  
Cow numbers: 320  
Cost: $50 000  
($156/cow)  

Feed shed  
100 m long, 12 m wide, and 3.6 m high facing north-south. The roof pitch is 10° and the floor is cement and gravel.  

Feed trough  
Comprised of conveyor belting bolted to steel supports, 90 m long with 1 m inside width and 500 mm inside height. The troughs face north-south.  

Cleaning system  
Dry scraped when required with manure stockpiled and later sold.  

Comments  
When the water troughs were shifted next to the shed, intake and milk production increased.  

Geoff and Michelle Parrish  
PO Box 153  
Wellington NSW 2820  
Phone: (068) 452 172  

System type: Shade and feed shed  
Year built: 1990  
Cow numbers: 160  
Cost: $50 000  
($313/ow)  

Shade shed  
30 m long, 24.2 m wide, and 3 m high at the eaves, 6 m at the apex. The roof has a 15° slope and faces north-south. The shed cost $26 000.  

Feed troughs  
2 x 24 m long troughs, 2 m wide inside and 160 mm high inside with a wall thickness of 200 mm. The trough outside height is 500 mm. The cow control tape is 900 mm from bottom of the trough and 400 mm above the lip.  

Cleaning system  
Dry scraped once per week with the manure stockpiled and used for compost by the local council.  

Comments  
Would like to make lip higher and trough narrower. The shed paid for itself in 2 years through use in wet weather and to cool cows in summer.
R.W. Hodge and Son  
(Contact Stuart Hodge)  
PO BOX 430  
NUMURKAH VIC 3636  
Phone: (03) 5862 2407  

System type: Feed pad  
Year built: 1996  
Cow numbers: 850 (current)  
Cost: $147,500  
($173/cow or $471/m troughing)  

Feed pad  
173 m long, 19.2 m wide at the northern end, and 13.25 m wide at the southern end. The pad is facing north-south with a slope of 1 in 200. The cement floor is 125 mm thick. The cow alley is 6.7 m at the top and 4 m at the bottom.

Feed trough  
2 x 156 m troughs, 500 mm inside width at the bottom, and 950 mm at the top. The height inside is 375 mm on the cow side, and 500 mm on the other side. The wall thickness is 180 mm on the cow side, and 100 mm on the other side. Slip forming was $70 per linear metre. The supplier was Seovic Pty Ltd, Camden.

Central alley  
156 m long and 2.75 m wide. Cement floor is 125 mm deep.

Cleaning system  
Dry scraped every second day in wet weather with the manure stockpiled and spread onto pasture. Pad is set up for mechanically assisted flood washing.

Comments  
The central alley design gives the flexibility to split cows into groups when needed. The pad has a 30 year life span at a cost of $4916/year. Sprinkler system for cows cost $3000 in 1997.
**Geoff and Narelle Kleinschmidt**  
‘Otmoor’ Otmoor Road  
UPPER COOMERA Q  4210  
Phone: (07) 5573 1206

System type: Feed shed  
Year built: Pad in 1990, Shed in 1994  
Cow numbers: 270  
Cost: 
- Shed $56 000 ($207/cow)  
- Pad $18 000 ($67/cow)

**Cleaning system**  
Dry scraped or hosed once a day with the liquid irrigated onto pasture.

**Comments**  
Shed was worth a lot this summer. Much higher summer milk production since the roof went on. Alleys on the side need to be wider than 3.6 m for cow movement, and access to water troughs.

---

**Feed shed**  
65 m long, 15 m wide, and 3.6 m high at the eaves, facing NE-SW. The roof pitch is 19° and vents are 610 mm. The floor is cement. Cow alleys 3.6 m on side and 6.5 m in the middle.

**Feed troughs**  
2 x 50 m length troughs, 1 m inside width and 300 mm inside height, and 400 mm outside, with a wall thickness of 100 m and a 200 mm step outside trough.

---

**David and Gwen Roderick**  
‘Tredagar Park’ MS 126  
HARRISVILLE Q  4307  
Phone: (07) 5467 1322

System type: Feed shed  
Year built: 1992  
Cow numbers: 150  
Cost: $20 000 ($133/cow)

**Cleaning system**  
Dry scraped, being partially cleaned every day, and fully cleaned twice a week. The manure is stockpiled and spread onto pasture.

**Comments**  
It is very hard to keep the floor from wearing, needs topping with gravel and rolling every 5 years. Shed is indispensible due to lack of trees and useful for controlling mastitis.

---

**Feed shed**  
70 m long, 7 m wide, and 4 m high, facing north-south. The roof is sloped with the lowest point to the west. The floor is of compacted gravel.

**Feed pad**  
70 m long, 2 m wide, with 2 electric wires 1.4 m high for cow control. The floor is cement and there are no walls on the feed out area.
Colin and Chris Heathwood  
MS 331 GOOMERI  Q  4601  
Phone: (071) 687 224

System type: Feed shed  
Year built: 1993  
Cow numbers: 200  
Cost: $50 000  
($250/cow)

Cleaning system  
Dry scraped once per week with the manure being stockpiled and spread onto paddocks by contractor.

Comments  
Nib wall on the feed side needs to be higher as cows put their feet over the wall.

For $100 this simple removable device built by Chris Heathwood at Goomeri allows feed to be pushed up quickly in their central feed alley system. The dog is not included in the price.

Feed shed  
115 m long, 15 m wide, and 12 m high at the eaves, 14.6 m at the apex. The vent is 600 mm wide, and it is facing east-west. Longitudinal slope is 2m in 50 m, and the central alley is 5 m wide. The floor is cement.

Feed pad  
100 m long, the height of the nib wall is 450 mm on the cow side, and 300 mm on the feed side, with a wall thickness of 100 mm.

Colin Heathwood pushing back feed on the motorbike.
John and Calvin Hinchcliffe
‘Fairview’ MS 250 MILMAN
Via ROCKHAMPTON Q 4702
Telephone: (079) 343 196

System type: Shade/feed shed
Year built: 1997
Cow numbers: 140
Cost: $20 000
($157/cow)

Feed shed
50 m long, 10 m wide, and 3.6 m high at the eaves, and 5.1 m at the apex. The shed is facing north-south. The floor is cement with a slope of 3%.

Feed trough
42 m long, 1.3 m inside width and height inside of 600 mm. The wall thickness is 150 mm. Owner-builder.

Cleaning system
Dry scraped initially, but set up for flood washing. Cement floor has been extended beyond the roofline by 500 mm with a 200 mm nib wall.

John and Margaret Cochrane
Goomong Road
KANDANGA Q 4570
Phone: (07) 5484 3166

System type: Feed pad
Year built: 1997
Cow numbers: 300
Cost: $20 000
($67/cow)

Feed pad
95 m long, 9.5 m wide, facing north-south. Slope is 2% and the floor is cement with a 200 mm nib wall.

Feed trough
95 m long, 1.2 m width inside and 400 mm height inside. The wall thickness is 150 mm clay brick.

Cleaning system
Dry scraped, but set up for flood washing into a pond system.

Comments
Railway line was used as posts. Roof lacks a gap in the middle but shed will be useful for extreme tropical wet weather. Sprinkler system to be added later.

Comments
This is half of the final feed pad design. Pleased with the low cost for cow numbers involved. Milk production increased 3 L/day when cows went onto the feed pad due to reduced wastage.
Feed Pad

**Feed shed**
220 m long, 20 m wide, 3.8 m high at the eaves, and 4.2 m at the apex. The shed is facing east-west and the slope is 1 in 300. Floor is cement, with a 750 mm lip at the outer edge.

**Feed pad**
220 m long, and 6.7 m wide. The height of the nib wall is 350 mm, with 2 lengths of cable 1 m from the floor. The wall thickness is 150 mm.

**Central alley**
220 m long and 6.3 m wide.

---

**Cleaning system**
Flood washing (0.3ML over 20 minutes) is used to clean cow alleys. Water goes through a solids trap into a pond that also collects dairy effluent and is recycled through the shed.

**Comments**
Shed has sprinklers to provide extra cooling for the cows.

---

**Feed Pad DOWN UNDER**

<table>
<thead>
<tr>
<th><strong>System type:</strong></th>
<th><strong>Year built:</strong></th>
<th><strong>Cow numbers:</strong></th>
<th><strong>Cost:</strong></th>
</tr>
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<tbody>
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<td>Feed shed</td>
<td>1994</td>
<td>700</td>
<td>$200000</td>
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<tr>
<td></td>
<td></td>
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<td>($285/cow)</td>
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**Ged and Jan Nolan**
MS 394 WARWICK Q 4370
Phone: (076) 666 193

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<th><strong>Year built:</strong></th>
<th><strong>Cow numbers:</strong></th>
<th><strong>Cost:</strong></th>
</tr>
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<td>Feed pad</td>
<td>1991</td>
<td>180</td>
<td>$28000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>($156/cow)</td>
</tr>
</tbody>
</table>

**Feed pad**
60 m long, with 3 m wide cement standing area for cows next to the feed alley. The nib wall is 400 mm high and 100 mm thick. The floor is concrete and faces east-west. The supplier was Quickfloor, Marsden Brisbane.

**Central alley**
60 m long and 5.5 m wide.

**Cleaning system**
Dry scraped as required with the manure stockpiled and contract spread onto pasture.

**Comments**
A roof is needed over the feedpad to manage cows in hot and wet weather.
Feed shed
2 barns 60 m long, 32 m wide, facing east-west. Cement floor with grooving. Central alley is 5 m wide.

Feed alley kerbs
440 mm high on cow side, 310 mm on feed alley side. Cows have a 4 m wide alley next to the feed bank.

Cleaning system
Scraped in conjunction with flood washing.

Moxey Farms
(Contact Paul Moxey)
RICHMOND NSW
Phone:(045) 885551

System type: Free stall shed
Year built: 1997
Cow numbers: 180 cows per shed (360 total)

Individual head stalls or stanchion gates are useful for herd health or AI in large herds. Settings can be varied, but the 'Alber' stalls at Moxey's are 1020 mm high and spaced at 610 mm.

Free stalls have a bar on the top that only allows cows to enter the stall to lie down. They can't have their back feet on the sand which keeps most of the manure and urine on the cement floor. The sand is 200 mm deep on top of a cement base.
Orientation - east-west or north-south?

The correct orientation is an often discussed subject. For uncovered pads, orientation is probably not too important, unless it is planned to build a shed over the pad later.

An east-west orientation maximises the shade but minimises the entry of sun on to the floor under the roof reducing the drying and bactericidal effects of the sun.

A north-south orientation maximises the sun penetration under the roof, promoting drying and reducing bacterial populations but minimises the shade, particularly before mid-morning and after mid-afternoon.

The orientation decision is a definite compromise and depends on the individual farmer’s concerns about minimising disease, particularly mastitis, relative to his concern about heat stress. Most of the new sheds have been essentially north-south reflecting perhaps a preoccupation about disease control. Heat load is still minimised in a north-south shed in the middle of the day. Another compromise suggests north-south for sheds with cow access to the sides of the shed and east-west when access is only from the ends. Free-stall barns with their clean bedding areas are often sited east-west.

North-south is a wise idea for sheds relying on tractor cleaning of the pad. Some areas inside an east-west shed will never have direct sunlight. The floor will remain wet and a likely source of pathogens.

Central troughs or a central feed alley?

Trough design for dairy feed pads has been poorly researched in Australia. Our initial investigations would suggest a trough about 1.2 m minimum internal width for two-sided feeding with sides at least 400 mm high. Cows may easily become “cast” in narrow feed troughs should they be forced into them. Wider troughs or some system of a moveable trough which can be tipped over with a front-end loader to get a cow out of such a situation can be a partial solution. Some feed troughs can only be cleaned out manually which can be a real chore should cows reject significant quantities of feed.

Many consider that a central feeding alley for the tractor and feed wagon is essential. Such a system allows easy cleaning out of surplus or rejected feed allowing a completely fresh ration to be fed each day. However some system of pushing feed back to the cows is necessary. A simple blade attached to a four-wheel motorcycle can be used. The central feed wagon alley also allows the installation of self-locking stanchion gates which can be a boon in capturing cows for AI or herd health purposes. A central feed alley
Concrete finishes

also allows segregation of cows into groups much easier than a central feed trough design.

The concrete surface on a feedpad is always a compromise. The surface must be rough enough so that the cows do not slip while still able to be cleaned well and not cause hoof damage. Our experience in Australia, based mainly on dairy sheds and yards, suggests that it is difficult to make the surface too rough and many surfaces which seemed rough at the start have worn smooth, needing grooving or roughening.

However, the cows spend only 2 or 3 hours per day in a dairy and pasture-fed cows seem to wear concrete rapidly. Cows kept in a free-stall system for 24 hrs per day seem to be more susceptible to hoof damage and thus require smoother surfaces.

Concrete finishing systems which have proved successful for short-duration feed pads have included a roller made of aluminium security door screen used shortly after the concrete has been “bull-floated”.

Another alternative is a roller made from three car wheels (no tyres) welded together and used in a similar fashion to the security mesh roller (makes a pattern of longitudinal grooves).

Systems where the cows are held for longer periods may demand smoother surfaces as can be formed using a bull-float which has had expansion-joint formers fixed at regular intervals across its surface. Such a system leaves parallel grooves about 10 mm wide at 150 mm intervals.

In Florida, rapid hoof wear on concrete surfaces demand very smooth surfaces formed by finishing the concrete very smooth with a “helicopter” trowelling machine. The uncured concrete surface is grooved the next day (12mm wide grooves, 10 mm deep, and about 60mm apart) using concrete sawing equipment.

A very simple method of forming a pattern into the concrete after final working, using a 4 m wide heavy gauge mesh. This is done in the cow standing area next to the feed trough. This photo was taken during the construction of J. and M. Cochrane’s feed pad, Gympie.

A floor pattern made using mesh stamped over shade cloth to give the rounded profile.
A floor pattern made using the security door mesh roller, made from aluminium door mesh.

Cement pattern produced with a roller made from 3 x 350 mm car wheels welded together. Cross pieces welded at regular intervals around the rim. This is used after bull-floating and leaves a tile-like pattern.
A concrete floor with grooves formed by a bull float with expansion joint formers attached at 140-150 mm spacing. Grooves are 10 mm wide and 12 mm deep.

This concrete pattern mould is made from angle iron and is held at either end by the handles.
Feed pad maintenance

Mechanical scraping

Mechanical scraping with either a front or rear blade mounted on a tractor is a common pad cleaning system. Steel blades wear rapidly on concrete surfaces as does the concrete surface. A better alternative may be a rubber blade perhaps fashioned out of an old tractor or earthmover tyre or a purpose-built box scraper.

Mechanical scraping has the advantage of being cheap and the manure remains dry (in dry weather), and more suitable for spreading or for further processing. Mechanical scraping is the only option for pad surfaces other than concrete.

Mechanical scraping has the disadvantage that it is another job and generally does not get done as often as it should. The tractor gets manure all over it which can lead to rusting and more maintenance. A scraped feed pad will also never be as clean as a washed feed pad.

Any manure stockpile formed by scraping must be in a controlled drainage area so that drainage is incorporated into the waste management system.
Spreading slurry

John and Nancy Morrow
‘Glenrowan’ Eugowra Road
CANOWINDRA NSW 2804
Telephone: (063) 442 097

Dry scraping and stockpiling for later spreading on pastures is common as seen here at John Morrow’s farm Canowindra NSW.

The glywheel, seen at the front of this machine, shreds the material and propels it through a side opening. Breaker tynes near the exit are adjustable to give an even application. When loading and transporting, a slurry door separates the main chamber from the flywheel allowing liquids to be utilised.

Spreading solid manure using a Keenan Orbital spreader. This machine uses a heavy duty hydraulic ram attached to a sliding rear door that pushes the material from the back to a rapidly spinning flywheel.
Scrapers

A scraper made from half a tractor tyre.

A box scraper attached to the rear of a tractor.

Fall

Most feedpads benefit from some fall in at least one direction. Gravel feedpads should fall in one direction at 2-4%. This will reduce mud accumulation and minimise possible odours.

Concrete feedpads to be flush-cleaned need to have 2-3% fall in the longitudinal direction to clean properly.

A feed pad site prepared with longitudinal fall of 3%. Site preparation costs were less than $1000. On flat sites where earth needs to be built up, an earthmover can take soil from the intended pond and use it under the feed pad.
Hosing

Concrete surfaces can be hosed by a high-volume low-pressure system similar to that used for dairy holding yards. It is simple technology and a perfectly clean feed pad should result. The secret is in the volume delivered at the end of the hose. Aim for 450 L per min which means that at least 38 mm or 50 mm hoses will be needed. Very long hoses could be required. A better alternative would be overhead booms or short, easily disconnected hoses. Hosing is likely to be time consuming and not done very often, it may be reasonable in wet weather while the pad is mechanically scraped in dry weather. When the manure is dry it can be very hard to shift.

This feed pad owned by Geoff Kleinschmidt, Upper Coomera, Queensland, is hosed and scraped to provide a clean, comfortable environment for the cows.
Flood or flush cleaning

Flood or flush cleaning has become popular in Australia for cleaning holding yards at dairies. The yard is usually cleaned in seconds with minimal labour input. The systems usually consists of a holding tank for fresh or recycled water from the effluent pond and a series of butterfly valves and pipes to direct the water to the holding yard. The main variable in water volume and flow rates required is the width of the yard to be flushed and a flush volume of 500 L per metre of yard width is often recommended (Wrigley 1994).

Most of the newer barns in the USA have flush cleaning but usually much higher flow rates and volumes are necessary to deal with the increased volume of manure encountered in a 24 hr a day holding situation. The USA recommendation to flush clean a 3m wide alley, 60 m long with a slope of 2% will require a flush volume of 6460 L at a discharge rate of almost 30 000 L/min (Fulhage & Martin 1994). These are very high flow rates needing 300 mm or larger pipes to maintain the discharge rates.

Current Australian experience with flush cleaning feed pads is quite limited. It is likely that lower flow rates than the USA recommendations will be adequate for cows held for short periods in a feedpad.

Pre-wetting of the manure with sprinklers (good for heat stress management) or soaker pipes will greatly assist manure removal and enable smaller pipes and flow rates. A 250 mm pipe to clean a 6 m wide alley does a reasonable job in Queensland, although dry manure is often left behind so 300 mm would be preferable.
Flood washing is using recycled water to clean the shed. Water volumes need to be carefully matched to the floor width and slope to ensure a good clean surface. The system is easy and cheap to operate and gives a cleaner finish than scraping. The underground pipe should preferably be at least 300 mm for this 6 m wide alley.

Cows adjust to flood washing very quickly. It is the most effective method of cleaning feed sheds and pads.
Flood wash systems can use a flush pump which pumps the water directly from a pond to the pad. To get the large flow rates such as recommended in the USA, 50-100 hp electric motors are required. The flush pump system has the advantage that very long flush times can be used (60 min or more). A reasonable Australian compromise is a flush pump operating at the same time as mechanical scraping — mechanically assisted flood cleaning.
Recycled water being used to flush the cow alley from an underground pipe. The water flows through an air-operated underground valve, lifting a hinged cover before flowing down the alley.

This car tyre held in place by a cantilever acts as a valve to store and release water from a flushing tank to clean a cow alley. Note the grooves in the cement parallel to the water flow.
Liquid waste management

Flushed and hosed systems
Management of waste water from feedpads systems with their better water quality will be more suited. First ponds must be sized to handle the expected volatile solids loading and must include an allowance for sludge accumulation. First pond size and sludge accumulation rates can be reduced by partial solids removal either with trafficable solids traps or with mechanical solids separation equipment. Unfortunately, such equipment comes at a high price either in labour or capital. Wrigley (1994) has detailed information on pond sizing for various situations.

Scraped systems
Most manure is removed by scraping but storm water run-off from such areas can pollute.

Manure seal
Earth and gravel surfaces usually build up a seal in combination with manure after a period of use. It is important during cleaning or scraping that all the manure is not removed. A small amount should be left behind to retain a manure seal which will prevent infiltration of manure nutrients beneath the pad.

Controlled drainage area
The risk of surface water pollution during high rainfall periods can only be eliminated by the concept of a “controlled drainage area”. The area around the feedpad and manure stockpiles must be surrounded with banks or drains so that surface water from other areas does not run through the area and so that the run-off from the feed pad area does not enter watercourses.

Run-off collection ponds
Usually a pond must be constructed to hold the polluted storm-water for subsequent pumping and irrigation. Lott (1994) suggests that run-off ponds should be designed to hold all the run-off from the controlled drainage area in a 90 percentile wet year. This size is easily calculated from rainfall records for the district, the size \( (m^2) \) of the area and the run-off coefficient for the surface concerned. As the main variable in the size of the retention pond is the size of the controlled drainage area, it follows that this area should be no larger than necessary.

A well designed pond at the Wallace family dairy, Kiewa Valley, Victoria
Solid traps

When large numbers of cattle are held for long periods, a sedimentation basin or solids trap is often constructed before the pond to reduce the solids entering the pond. Such systems are common for large beef cattle feedlots.

Small solids traps fill quickly and can be a real chore to clear out. A better alternative may be a large (100 m long) earth trap with a compacted gravel base which may need cleaning only 3-4 times per year.

Westbrook Correctional Centre, Qld.
(Contact Trevor Telford)
Phone (076) 306 201

This low cost solids trap consists of a 100 m long ditch with a compacted gravel base. Effluent from the dairy and feed pad enter at opposite ends of the ditch.

The slight slope allow solids to settle prior to going through a weeping wall into a pond for irrigation. Manure and solids can be excavated by tractor bucket when needed. This design will reduce the volume needed in the pond by half, as approximately half the solids will settle in the ditch.

Weeping wall at the middle of the settling ditch. Water goes from here into the pond.
The frequent emptying of solids traps is a time consuming job. So unless the solids are needed for fertiliser or for resale then traps need to be built on a large scale, (as shown in a USA feedlot dairy, above). Alternatively the effluent pond can be built large enough to accommodate all solids for 5 years, then an excavator can desludge the pond.
Loafing pads

Hot and dry weather

The primary purpose of most Australian feedpads is usually as a feeding system sometimes combined with a roof to minimise heat stress or wet weather. As such, the cows usually remain standing and loafing areas may not be necessary. When held on a concrete floor for 5-7 hours during the hot part of the day about 10% or less of cows will lie down, particularly if fresh feed is kept in front of them. However, when cows are held for 10 hours per day or longer, many more will lie down and concrete is a very poor surface for cows to lie on. Some sort of loafing area becomes necessary.

Wet and cold weather

In areas of high seasonal rainfall, such as New Zealand or southern Australia, where soils are prone to pugging, and pasture damage is a problem, loafing pads are proving themselves popular and effective. These pads allow cows to stand off the paddocks without damaging feet and joints as can be the case on concrete. In areas with clay and peat soils, loafing pads are of extra merit as they reduce pasture damage in the short and long term.

In dry weather this is a shady loafing site for cows, however, with rain, these sites generally turn to mud which leads to increased mastitis.
Types of loafing pads

A sacrifice paddock
This is the simplest form of loafing area. They cab be satisfactory on some soils, particularly on hard hillsides with shade trees. Unfortunately the cows often pick on a few of the best shady tress and transform the area underneath the tree into a muddy slop with all the associated worries of environmental mastitis. Usually the only solution is ro electric-fence off such areas until they dry out and force the cows tro use other tress.

An adequate loafing area, such as this one at the Mutdapilly Research Station, is required, away from feed pads, so that cows are not forced to lie in the dirt, manure, and mud. A sloping site is preferred for good drainage. Note the large water troughs close to shade.

Cows resting on a poorly-cleaned feed pad - a recipe for environmental mastitis. Both pads and loafing areas need to be managed for manure loads.
**Constructed loafing pads**

These are becoming more common. The most common Australian example would be the rice hull pads usually used for calving pads in Northern Victoria. These may consist of a compacted clay base often with slotted sub-surface drainage pipes 1.5 - 3.0 m apart falling at 1% or more. The slotted pipes are covered by 20 mm gravel. This is in turn covered by an 80mm layer of coarse sand and then 600mm or more of the rice hulls. Manure is removed as much as possible from the top of the rice hulls and more hulls are added when the surface gets too contaminated. Once each year (or two years) the hulls must be removed as an impervious layer of manure and hulls is formed. These systems work well as calving pads for seasonal calving herds, but not many have been used as loafing pads for milking cows. Rice hulls are an organic form of bedding which will support bacterial growth particularly when wet. Environmental mastitis organisms could grow in such an environment. Pine bark, saw dust and even straight sand could be alternatives to the rice hulls. Some saw dusts are notorious for breeding mastitis pathogens (*Klebsiella spp*).

**Gary and Lisa Flanigan**  
**KATAMATITE, VIC**

350-500 mm of rice hulls are used as a loafing pad cover. Cows are put onto the pad 3 weeks before calving. The pad is cleaned each year and either spread over pasture or sold to gardeners.

**R. W. Hodge and Son**  
**NUMURKAH, VIC**

A constructed rice hull calving pad. The hulls often need to be stockpiled as they are not available out-of-season. The shade cloth fence is to stop the wind blowing the hulls away.

Allow 10 square metres per cow. A shade cloth fence may be needed to stop the rice hulls blowing around.
Compacted gravel

Compacted gravel is the next cheapest alternative for loafing areas. The gravel should be chosen carefully to avoid sharp stones, with sufficient clay or fine material so the mixture will compact well and set hard, minimising the number of free stones. Gravel stabilising agents sprayed on and mixed before compaction have been used successfully. Crushed limestone (white rock) is a good gravel for tracks and loafing areas. It packs down well and alkalinity of the limestone may have a slight anti-bacterial effect. Gravel loafing pads should fall at 2-4% to allow the water to drain away.

Mutdapilly Research Station

The experimental loafing pad is scraped clean at the start of each year and sand is brought in to cover the dirt after significant rain falls. The concrete is scraped daily by tractor bucket. Cows are on the pad during the day and graze at night.

Sam and Fleur Tonge
CASINO, NSW
Phone (066) 673 248

Cows standing on a gravel pad where the soil has been mixed with a stabiliser (Terra Firma). In wet weather this provides a firm base for cows feet but small stones will surface and cause hoof damage. This pad was put down in 1993.
**Bedding material**

Inert materials which will not support bacterial growth at least while they remain clean are the best bedding materials. Sand, usually river sand with not very much silt included, is clearly the material of choice. It is used widely in free-stall barns, in simpler systems such as the Florida "beach barns" and even over concrete in the tie-stall barns of North America.

The free-stall system can be very successful in keeping the sand clean in the stalls but its expense and labour commitment will limit its application to just a few Australian dairy farms. The majority of loafing pads will have to be regularly cleaned mechanically and fresh bedding material added to maintain a clean loafing environment. Sterilants such as burnt lime, hydrated lime or formalin-type products have been used to reduce bacterial populations in bedding materials but the sterilising treatment would need to be done very often (every second day) to have any real effect on pathogen populations. Some of these sterilisers could burn the cows.

Another alternative loafing idea is the Florida “cow carpet” system. The natural soil (usually sand in Florida) is graded with a suitable fall. Cow carpet, a synthetic geotextile often used in highway construction, is laid and then covered with 100-150 mm sand. The top of the sand layer is cleaned with tractor and box or tyre scraper and fresh sand added.

The Geotextile keeps the sand separate from the mud and can be kept clean by scraping. Caution: on sloping sites, surface water must be diverted away from the pad and the Geotextile must be well anchored. Adequate drainage is also required under the Geotextile.
A calving pad made from bark chips approximately 1.5 m deep over agricultural drain pipes set every 3 m across the pad. Cows calve on this pad and are fed a special dry cow mix in the feed troughs adjacent to the calving pad.

The stockpile of chips are seen on the bottom photo on the left. A large water trough is placed in the centre of the pad. The drain pipes are brought to the surface on one side to allow for easy cleaning of blockages.
Shelter

In low latitude dairy regions, cows will use a lot of energy in winter to keep warm. Windbreaks or planting trees to reduce cold winds are a good idea. Natural inclines and earth taken from a pad can be used as a shelter wall. Straw in round or square bales stacked besides the pad or concrete iron or corrugated can break the prevailing wind. Walls higher than 2 m will cause eddy effects and direct wind down onto the cow’s backs.

It is important to provide as much shelter as possible while still allowing movement of fresh air.

Location

As with real estate, the three things of most importance with a loafing pad are location, location, location! They must be close to milking and feeding facilities. If they are difficult to get to, farmers won't use them and they are more inclined to put cows back in the paddock. If you clear the water table by 1 m and all the drainage pipes are above the water table, the pad should function perfectly no matter how much it rains.

Area per cow

The area required is a minimum of 15 m$^2$ per cow, if you intend to keep cows there for weeks on end. However you can reduce this to 9 m$^2$ if they are being fed on a pad and get a few hours a day in the paddock for exercise. Smaller areas will need more cleaning and management.

Management

It is critical to clean the pad at regular intervals to prevent muck building up on the top layer. If not done the top layer is liable to turn to porridge, and water won't drain easily through this layer once it is destroyed and cows will start sinking into it. When cleaned regularly (once a week) the water will soak away and the top surface is reasonably dry.

Cows will behave on the pad as they would in the paddock. If they are hungry they will stand at the gate and bawl. This would obviously destroy the areas around the gateways, so it is a good idea to fence them back on the pad with a reel of tape. You can also subdivide a pad in this manner to put different mobs on it. When holding dry cows on the pad, supply straw in round bale feeders to give them something to eat during the time they are on the pad. Along with improving rumen capacity it gives them something to do.

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Advantages of an integrated loafing-feed pad

- No pugging of wet pasture.
- Higher pasture yields.
- Less energy expended in walking cattle, especially in hot weather.
- Less time is needed to muster cows to milking
- Less damage to laneways and gateways in wet weather.

Disadvantages of a loafing pad

- Effluent from the pad must be disposed of.
- Nutrients are transferred from the pasture to the pad in the form of manure and urine.
- Capital cost can be high.
Using feed pads to cool cows

Feed pads are built to minimise wastage of feeds such as silage, hay, grain, protein meals, byproducts and expensive mineral and vitamin pre-mixes. In many parts of Australia covering the feed pad with a shade structure will lead to an increase in intake and milk yield that justifies the extra capital outlay.

The cost of heat loads in lost milk income can be calculated from a CD-ROM and associated book (‘Managing hot cows in Australia’ - T.M. Davison et al 1996). The CD-ROM is available through dairy advisers and consultants in Australia using milk yield, milk price and herd size along with the known climate data from the nearest meteorology station an estimate of loss in milk yield over the hotter months can be calculated. For herds in coastal Qld, the Hunter Valley, the Riverina, northern Victoria and parts of WA and SA some of the estimates are between $10,000 and $35,000 per year depending on herd size.

The losses from reduced conception rates, milk protein % and fat %, liveweight loss, higher somatic cell counts, and clinical mastitis can often double these losses. These calculations do not take into account carry-over effects of hot weather on subsequent lactation milk yields, and so are conservative estimates.

**Losses**

The table below shows the loss in milk income (at 25 c/L) for a 200 cow herd, producing 20 L/day or more at the start of summer, at 4 sites in eastern Australia. Lost income is compared for farms that have poor (for example little or no tree shade) with very good (corrugated iron with sprinklers and access to feed) cooling strategies.

The loss in milk income will depend on the level of milk production of cows at the start of the hot season, how well adapted they are and what integrated strategies have been put in place by the farm manager to alleviate environmental heat load.

**Lost annual income ($) from milk only at 4 sites, due to level of heat load management, for a 200 cow herd receiving 25c/L.**

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<th>Site</th>
<th>Poor ($)</th>
<th>Very good ($)</th>
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<td>2,900-5,800</td>
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<tr>
<td>Scone (NSW)</td>
<td>17,800-35,600</td>
<td>4,100-8,150</td>
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<tr>
<td>Gympie (Qld)</td>
<td>7,500-15,000</td>
<td>400-800</td>
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<tr>
<td>Rockhampton (Qld)</td>
<td>14,500-29,000</td>
<td>1,050-2,050</td>
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</tbody>
</table>

A common Australian scene — nil or limited tree shade for cows on a hot day and water troughs placed in the middle of the paddock, away from tree shade sites.
Investment options

An experiment at Mutdapilly in south-east Queensland compared six investment strategies to cool and shade cows.

**Strategies**

- Corrugated iron with sprinklers that came on for 2 minutes and off for 12 minutes when the temperature was above 26°C.
- Corrugated iron.
- Cows without shade, but with sprinklers.
- Cows under shade cloth (where 65% of the photosynthetic light bands do not penetrate shade cloth).
- Cows under 65% shade cloth with a 2 km walk.
- Managed - cows in sun but sprinkled at the dairy at midday when respiration rates were above 80 breaths/minute.

**Summary of results**

- Cows under corrugated iron produced 1.0 L/day more than cows under shade cloth over a 3 month period in summer.
- By using sprinklers under corrugated iron this increased the production difference above shade cloth by 1.7 L/day.
- During a 14 day heat wave, cows under corrugated iron with sprinklers produced 3.0 L/day more than cows under shade cloth.
- Cows that had to walk 2 km produced more than 2.0 L/day less than cows with corrugated iron and sprinklers, had lower fat and protein yields, higher somatic cell counts, and lower pregnancy rates.
How do you tell if cows are losing milk due to heat load?

- If the respiration rate is above 70 breaths/minute then cow cooling strategies need to be implemented to maximise milk yield and reproduction.
- This will correspond to a rectal temperature of approximately 39°C.

Respiration rate can be measured by counting the number of flank movements in 15 seconds, and multiplying by 4.
Costs and returns - a case study

Before spending any money on heat management strategies it is important to know the costs involved and the returns. It is true however, that economic returns may not always be the reason for their use. For example, the erection of shade structures may be a future requirement to improve animal welfare.

This is already evident in beef feedlots where the provision of shade is a necessary response to improve animal welfare.

Profitability will depend on initial cost, depreciation and interest rate, herd productivity, the severity of Temperature Humidity Index, and number of days that cows are under high heat load.

This case study relates to Holstein-Friesian cows producing over 20 litres per day at the Mutdapilly Research Station for 3 months over one summer. It provides a conservative estimate as it does not take into account carry-over effects of heat load.

A cost was put on the effects of heat load on milk yields, cow liveweight, feed intake and reproduction, comparing five cooling strategies with a minimal cooling management of sprinkling cows for 45 minutes at 11.30 am if their respiration rate averaged over 80 breaths/minute.

Where farms have little or no shade then the milk responses and dollar differences recorded here would be even greater.
Economic analysis of five cooling systems for 100 cows

The analysis is based on a comparison with a control milk yield of 21.3 litres per cow with 2.8 inseminations per cow and a weight gain of 0.4 kg per week for a 3 month period during summer.

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<td>160</td>
<td>37.5</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Total cost for the system ($)</td>
<td>19750</td>
<td>16000</td>
<td>3750</td>
<td>6000</td>
<td>6000</td>
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<tr>
<td>Depreciation rate applied (%)</td>
<td>4.5</td>
<td>4</td>
<td>10</td>
<td>20</td>
<td>20</td>
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<tr>
<td>Production changes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk output (L/cow/day)</td>
<td>24.2</td>
<td>23.5</td>
<td>22.5</td>
<td>22.5</td>
<td>22.3</td>
</tr>
<tr>
<td>Extra milk (L/cow/day)</td>
<td>29</td>
<td>22</td>
<td>1.2</td>
<td>1.2</td>
<td>1</td>
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<tr>
<td>Extra milk from 100 cows (L)</td>
<td>26680</td>
<td>20240</td>
<td>11040</td>
<td>11040</td>
<td>9200</td>
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<tr>
<td>Feed mixture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry matter intake (kg/day)</td>
<td>14.9</td>
<td>14.6</td>
<td>13.7</td>
<td>13.6</td>
<td>12.7</td>
</tr>
<tr>
<td>Extra dry matter (kg/day)</td>
<td>1.5</td>
<td>1.2</td>
<td>0.3</td>
<td>0.2</td>
<td>-0.7</td>
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<tr>
<td>Cost of extra DM ($/kg)</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
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<tr>
<td>Changes in running costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of prodn for extra milk ($)</td>
<td>800</td>
<td>607</td>
<td>331</td>
<td>331</td>
<td>276</td>
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<td>Feedout costs or savings ($)</td>
<td>2760</td>
<td>2208</td>
<td>552</td>
<td>368</td>
<td>-1288</td>
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<tr>
<td>Interest on loan at 9% ($)</td>
<td>1777</td>
<td>1440</td>
<td>337</td>
<td>540</td>
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<td>Repairs and maint at 1% ($)</td>
<td>197.5</td>
<td>160</td>
<td>37.5</td>
<td>60</td>
<td>60</td>
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<td>Electricity cost (1.8 kwh) ($)</td>
<td>27</td>
<td>0</td>
<td>27</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Water use ($)</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Depreciation ($)</td>
<td>889</td>
<td>640</td>
<td>375</td>
<td>1200</td>
<td>1200</td>
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<tr>
<td>Extra labour for mustering ($)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1196</td>
<td>1196</td>
</tr>
<tr>
<td>Total of extra costs</td>
<td>$6 458</td>
<td>$5 055</td>
<td>$1 667</td>
<td>$2 499</td>
<td>$1 984</td>
</tr>
</tbody>
</table>

Income from extra benefits

| Extra milk at 21.3c/L($) | 5949 | 4311 | 2351 | 2351 | 1959 |
| Weight change (kg/week) | 1.26 | 0.41 | 0.35 | 1.01 | -0.33 |
| Value of weight change ($) | 1965 | 639 | 546 | 1576 | -515 |
| Decrease in AI’s/cow | 1.1 | 0.8 | 0.3 | 0.3 | 0.7 |
| Decreased days open | 2310 | 1680 | 630 | 630 | 1470 |
| Total of extra benefits | $10 224 | $6 630 | $3 527 | $4 557 | $2 914 |

Net Gain | $3 766 | $1 575 | $1 860 | $2 057 | $930 |

See following page for basis of calculation of individual costs.
Cost - benefit assumptions

Cost of shade structures
Structures to be placed above an existing cement feed pad.

Corrugated iron shed
- Calculated at $40/m² for an open shed at 4 m²/cow.

Shade cloth and structure
- $50-70/cow
  Calculated at $15/linear meter (3.5 m wide) = $17 for 4 m² for shade cloth, plus $40/cow for structure.

Sprinklers, lines and pump
- $37.50/cow for 100 cows
  Calculation includes automatic timers, and fittings. The price per cow will be less for larger herds as the pump will service more than 100 cows.

Depreciation rate (%)
It was assumed that a corrugated iron shed will have a life of 25 years while shade cloth will have a life of 8 years. Depreciation of pumps and sprinklers are included in the relevant options.

Milk price
Milk price is based on manufactured milk rates for summer 1996/97 in Queensland (21.3 c/L) (including domestic market support payment and protein bonus). The higher rate for Option 1, (22.3 c/L) is due to the higher quantity of milkfat in the milk.

Dry matter intake
This refers only to the more expensive (20c/kg DM) mixed ration fed during the day. Pasture intake was not measured.

Cost of production for extra milk
The total 'extra' milk yield multiplied by levies, cartage and cooling. This is approximately 3c/L.

Interest
Interest on loan is based on 9% p.a.

Labour
Labour is costed at $13/hour.

Repairs and maintenance
Repairs and maintenance is set at 1% per annum of the value of the structures.

Cost of AI
Insemination is priced at $15 per dose.

Decreased days open
This is the value of improved reproductive efficiency gained by using one of the cooling options. These values are the gains above the lowest yield option.

The equation used is as follows:
(Number of cows x 0.25) x Number of extra inseminations x 21 x $4.00

This assumes:
- that 25% of the herd is being mated over summer months
- 21 days of oestrus cycle
- $4.00 cost per day for empty cows.

Electricity
1.8 kwh to pump approximately 2600 L which was used per cow over the 92 day study. Electricity has been costed at 15c/kwh.

Water
Estimated cost of extra sprinkling water.

Value of weight change
1 kg liveweight gain is equivalent to approximately 8 kg DM intake. In this case the difference in weight change from the lowest yield option has been used e.g. for option 1 the cows gained 1.26 kg/week more than the control. The average cost per kg DM intake is 15c.
Integrated plan

An integrated whole farm approach to the cooling of cows needs to be planned for your farm. A range of low and high cost options are presented.

Low cost

• Milk cows later in the afternoon — after 5 pm (AEST).
• Don’t walk cows at the hot time of the day.
• Give cows the best pasture at night, preferably legumes.
• Plant some trees on the western side of the dairy.
• Put sprinklers up in the dairy yard, wet cement prior to herding cows, and wet cows for 30 minutes prior to the afternoon milking.
• Consult your nutritionist about energy dense rations.
• Put a larger water trough on the exit side of the dairy.
• Use only cool water in water troughs

Capital costs

• Put a shade cover over your feed pad and feed the cows during the day.
• Incorporate a timer and sprinkler system under the shade shelter.
• Larger water troughs with cool water in paddocks with regard to position, recharge rate and pipe size.
• Plan an integrated tree planting programme for your farm with your local Landcare or Forestry specialists.

Fouling of creeks, channels, and waterways by cows is one reason why covered feed pads or shaded areas need to be provided for cows. These cows are in the creek from 8 am to 4 pm on hot days. Plenty of water, but no feed so it is not a solution to maintain production.
Recommendations for shade structures

Roofing
- The lowest point of the roof should be at least 3.7 m (12’) from the ground.
- Allow 3.5 m² - 4 m² of roof area per cow (includes troughing) for use up to 12 hrs per day.
- The use of aluminium, white or galvanised roofing material is preferred, shade cloth is low cost but will provide less cooling.
- Use a roof slope of 19° vented at the top (300 mm + 50 mm per 3 m of width for sheds with a width of over 6 m), to create movement of air through the shed.
- Finish the roofing 0.5 m inside the concrete to allow rainwater to fall on cement.

Flooring
- Concrete floors and an adequate waste handling system will minimise mastitis.
- The floor should have a 2-3% slope to allow for a flush cleaning system with water running into a recycling dam, nib walls 200 mm high are required on the side of flush bays.
- A slope steeper than 3% will increase the likelihood of tractor wheels slipping when pulling feed wagons, a slope less than 2% can be flood washed in combination with mechanical scraping.
- If the shed doesn’t have a concrete floor and is excessively wet, routine mounding under the shed with fresh sand, or compacted gravel may help.

Orientation
- A north-south orientation is preferable to allow the sun to dry underneath both sides of the shed.
- An east-west orientation is not recommended as the southern side will always be wet predisposing to mastitis and this area may need to be fenced off.
- Movable shade cloth or screens can be used on the sides in wet, windy weather to protect cows and feed.

Feeding
- Position the water on the eastern and western edge of a north-south shed to reduce walking to water and preferably position feed troughs under shade.
- Position the feed and water on the southern and northern side of an east-west orientated shed.

Cost
- An open sided shed costs around $40 per m².
- Cost of sheds vary from $150-300 per cow depending on the amount of concrete, cost of roofing and support structure.
- Life expectancy of a shed structure is at least 25 years.
- The benefit/cost ratio based on the expected increase in milk production is around 2- 3:1 for a well made structure.

Sprinklers
- Sprinklers need to be suspended 2.3 metres from the ground above the feed troughs or pad and the water directed onto the backs of the cows. The droplet size should be medium to large depending on ambient humidity.
- It is important to install a filter at the beginning of the waterline and the sprinkler nozzles should be easily removed for cleaning.
- The nozzles (90° to 360°)should be directional, if possible, so that for major prevailing wind shifts they can be adjusted to reduce the wetting of feed.
Installing a sprinkling and fan cooling system

Farm requirements and principles

- In humid environments where there is little breeze it is preferable to blow air onto cows with fans, in addition to sprinklers, in order to evaporatively cool. Fans generally run continuously to save wear on belts and motors. In low humidity environments the rate of air flow will determine the efficiency of sprinklers.

- An ample water supply (100-150 litres per cow per day).

- Roof over area where cows are to be cooled.

- Facilities to collect and handle run-off (2-3% sloped concrete floor).

- Feed and water in close proximity to cooling area. The cooling system only can be effective if it results in more feed intake and milk yield.

- Sprinkle cows for 1 to 3 minutes and apply 1 to 2 mm of water per 15 minute cycle.

- Evaporative cooling can be used in any covered area with a concrete floor.

System design

- Timer - 15 minute adjustable type, attached to remote control valve (solenoid).

- Electrical remote control of sprinkler and fans - system should shut-off below 26°C if connected to a temperature sensor.

- Pipe size - depends on the length and area of facility to be sprinkled and the number of sprinklers and their flow rates. Up to 30 m use 32 mm pipe; 30 - 60 m use 51 mm pipe; and 60 - 150 m use pipe diameter of 76 mm, 51 mm and 32 mm for each 1/3 section.

- Pressure regulators - low pressure sprinklers (0.70 kg/sq cm) work best. Less velocity will give less mist and drift of spray. A main pressure regulator can be installed at the beginning of the pipeline.

- Location of pipe - depends on height of shed, posts or attachment points, width of area to be sprinkled and height at which fans can be installed. The pipe may be installed next to the feeding area. With 180° nozzles or in a wide feeding area 360° nozzles may be installed in the center of the cow alley under the fans.

- Spacing of nozzles - twice the radius of their throw; (for 1.2 m radius, space nozzles every 2.4 m). Sand or dirt may clog the nozzles so a filter should be installed before the first sprinkler.

Fans

- In sheds, fans can be arranged in many ways. A 0.5 hp, 0.91 m diameter fan rated at about 5 to 6 cubic m per minute will blow a distance of 9 m; A 1.0 hp, 1.21 m diameter fan, of 9 to 10 cubic m per minute will blow a distance of 12 m. The direction of flow should be with the prevailing wind. The size of fans and direction they face may depend on spacing of posts in the shed.

- In wide feeding sheds, the side-by-side spacing width of 0.9 m fans should be about 6 m, whereas for 1.2 m diameter fans the width can be 9 m.

- Fans should be tilted so that they blow down to the floor directly under the next fan (about 30° from vertical).

Source: D. Beede and D. Bray, University of Florida, Gainesville, USA.
Sprinkler-fan systems at Mutdapilly Research Station

Sprinklers under corrugated iron provide the most effective way to cool cows during hot weather. They are best operated on a 2-5 minute on, 13-10 minute off cycle with air movement to maximise evaporative cooling. Output per sprinkler was 2 L/minute.

Fans are expensive but where humidity is very high or air movement is very low can improve evaporative cooling.

Sprinklers
Thirty 90° garden nozzles spaced at 1.7 m apart along a 50 m feedpad 3.2 m from the ground. System includes a one hp electric pressure pump with regulator and 2 'Rotem' temperature/humidity timer controls (one to measure temperature/humidity under the shade shed, and the other for the open feedpad area).

Cost
$4,000 (includes labour).

Supplier
Martin Simmons, Outback Environmental Controls. Ph (07) 3352 6677.
Farm applications to cool cows

Ray and Warren Drynan
BEAUNESERT  Q
Phone:(07) 5544 1250, (07) 5544 2161

This shed design is state of the art in terms of cooling cows.

Geoff Parrish (pictured on left) discussing with Jeff Andrews, the conversion of this hay shed to a feeding shed for his cows. It is used in both wet and hot weather and Geoff believes the shed paid for itself in 2-3 years.
Feed shed
47 m long, 17 m wide, and 4.3 m at the eaves and 6.9 m at the apex, facing north-south with a longitudinal slope of 5%.

Feed trough
4 x 17.5 m, 650 mm inside width and 400 mm inside height, and a wall thickness of 100 mm. Height outside is 500 mm.

Cleaning system
Dry scraped, but set up for flood washing.

Comments
Covered feed pads can be built in two stages. These posts are set in place for a roof next summer.

Design
70 m long x 10 m wide x 3.7 m high with a 2.5 m rise in pitch. 80% Solar weave shade cloth was used. Structure has a 60 m long x 1.5 m wide feed trough and a cement floor.

Sprinklers
This shed has a sprinkler system with a sprinkler at every post (6 m apart) and 1.8 m from ground level (this is not high enough to be out of reach from cows). Garden sprinkler nozzles are used with a 180° span.
Cows are sprinkled with large water droplets from common garden sprinklers prior to the afternoon milking.

The feed pad also has sprinklers and is next to the dairy. The sprinklers cost $3 000 to install (see page 19).

Carl Greiss, ROCKHAMPTON, Qld

At this farm the holding yard is covered with corrugated iron with sprinklers set under the roof. However, the big gains in intake and milk yield are achieved by sprinkling and cooling the cows, next to feed, on covered feed pads, from am to pm milking.
Kevin Lang,
NATAL, SOUTH AFRICA

Kevin built this free stall shed in late 1996 for his Ayrshire herd. They rose 1.5 L/day immediately after entry to the shed to average 30 L/day. Average respiration rate of the cows on a hot day is 40-50 breaths/minute. The improved milk yield, reproduction and milk composition will easily pay for the shed.
Commodity bunkers

Open bunkers

Paul and Julie Ryan
RMB ‘Ingleside’
Calderwood Road
ALBION PARK NSW 2527
Phone:(042) 564 297
Type: Feed bunker
Year built: 1995
Comments
Excellent, very strong, easy assembled and a lifetime job.

Peter and David Mulcahy
RMB 1455
TONGALA VIC 3621
Phone: (058) 522 252
Type: Feed bunker
Year built: 1994
Comments
Bunkers need to be larger to hold 1.5 semi-trailer loads. Recommended 125-150 mm thick concrete and apron should be 7 m wide.

Feed bunker
18 m depth, 3.7 m wide, and 1.3 m high, with a wall thickness of 630 mm. Constructed from concrete blocks supplier from Nippy Crete Concrete at a cost of $20 per block.

Feed bunker
6 m in depth, 4 m wide and 1.5 m in height, with a wall thickness of 200 mm. Second-hand prefabricated cement walls and a slope to the front across a 5 m apron into a grate for drainage.
Feed bunker
10 m in depth, 3 x 4 m wide, and 1.2 m in height with a wall thickness of 150 mm. Constructed of reinforced concrete, supplied by Stockade Concrete.

Comments
A soil ramp has been built on the left hand side to allow easy discharge of soda grain into the end bunker. A 25 mm galvanised pipe has been laid on top of the walls to allow plastic to be stretched over bunkers and clamped with split poly pipe. Note the railway iron post to protect the bunker wall.
Feed bunkers
4 bunkers, each 6m deep, 4 m wide, and 1.6 m high side walls, and 2 m highest at the rear. Roof (4m high at rear, 6m high at the front) to be built over the bunkers. Bunkers, silage pits, molasses and feed pad are all within a 100 m radius. This is critical for fast loading and unloading of the TMR mix. Cement apron 7 m wide, with spoon drain, built in front of the bunkers for dumping loads and pushing into bays.

Peter Brown
'Migunburri'
MS 98 Christmas Creek Rd
BEAUDESERT Q 4285
Phone: (07) 5544 8156
Cost: $15 000

Jamie Gaver
Chino Valley
CALIFORNIA  USA

Feed bunker used for citrus pulp

Feed bunker
10 m in depth, 5 m wide and 1.5 m high, with a wall thickness of 200 mm. Constructed in concrete.

Comments
Slopes 200 mm from front to back to contain citrus juice. The annual rainfall is 350 mm.
Fixed or open roof feed bunker design

Plans for a dry commodity bunker

Each bunker holds 67 cubic metres and will store approximately 34 tonnes of whole cottonseed (500 kg/cubic metre).
The roof may not be necessary in low rainfall areas.
Front doors and fully enclosed sides may be necessary for tropical high rainfall areas.
Commodities can be dumped on the concrete apron and pushed back into the bunkers.
Roof is not high enough for a semi-trailer to tip directly into the bunker. Some cottonseed trucks have walking floors which can unload directly into this bunker.
Plans for a wet commodity bunker

Rear drainage allowed by leaving 30 mm vertical gaps between blocks on first row of back wall.

Each bunker holds 60 cubic metres and will store approximately 54 tonnes of brewer's grain (900 kg/cubic metre).
Sliding roof feed bunkers

John and Chris Keleher  
Keleher Rd  
MILMAN  
via ROCKHAMPTON  Q 4702  
Phone: (079) 343 146

Type: Sliding roof feed bunker  
Year built: 1996  
Cost: $8 762

Feed bunker  
15 m in depth, 8 m wide, and 1.8 m high, with a wall thickness of 200 mm. Constructed in concrete.

Open bunker (Soda grain storage)  
15 m in depth, 2.2 m wide, and 400 mm high, with a wall thickness of 200 mm and entry from both ends.

Comments  
Built with the lay of the land and roof is pushed open with the bucket on the tractor.

Bruce and John Carlson  
Carlson Road  
GYMPIE  Q  4570  
Phone: (07) 5485 5205

Type: Sliding roof commodity shed  
Year built: 1995  
Cost: $16 000

Feed bunker  
10 m in depth, 12 m wide (3 x 4 m bays), and 4.2 m high at front, 3.4 m at back. Constructed from reinforced besser brick.

Comments  
An additional 2.5 m cement apron is provided at the front. Holds 120 tonnes of whole cotton seed.
High roof commodity sheds

Lester and Dianne Ballon
MS 501
DALBY Q 4405
Phone: (076) 634 216

Type: Converted hay and grain shed
Year built: 1996
Cost: $7 200

Feed bunker
9 m in depth, 2.7 m wide, and 1 m in height, with 200 mm Besser blocks filled with reinforced concrete, 5 m apron at the front of the shed.

Comments
Bunkers need to be wider than 3.3 m. The low wall allows soda grain to be discharged out of the Keenan wagon into the bunker. Apron should be 7 m to allow tractor to turn without going onto the mud.

Simon and Sue Downes
Martindale Rd
DENMAN NSW 2328
Phone: (065) 472 778

Type: Feed bunker inside a hay shed
Year built: 1996
Cost: $200

Feed bunker (for soda grain storage)
10 m in length, 5 m wide, and 500 mm high, with a wall thickness of 50 mm. Constructed from wooden rails.
**Steve Fairley and Rob Fitzsimmons**
MS 1166
MILLAA MILLAA Q 4886
Phone: (070) 972 357 or (070) 972 304

**Type:** Feed bunkers  
**Year built:** 1997  
**Cost:** $47 000

**Feed bunker**
32 m long in 5 bays plus an open area, 4 m wide, 8 m deep, 2 m high back wall and 1.6 m internal walls. The bunkers are Besser blocks filled with cement and steel. Floor slope is 100 mm to front.

**Comments**
Need to raise height of internal walls to 2.2 m to fit 26 tonne load of whole cottonseed. Shed fully enclosed because of 2500 mm average annual rainfall.

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**Ray and Warren Drynan**
‘Eurara’ Telemon Crossing
BEAUDESERT Q 4285
Phone: (07) 5544 1250

**Type:** Feed bunkers in side a converted hay shed  
**Year built:** 1996  
**Cost:** $5 000

**Feed bunker**
7.2 m deep, 3.7 m wide, and 1.4 m high, with a wall thickness of 200 mm. The bunkers are reinforced Besser block.

**Comments**
Bunkers should be 3 m deeper and 1 m higher to fit 1.5 truck loads in each bay.
The device shown is hitched on the back of a tractor or truck and used to push feeds up inside high bunkers to maximise storage space.

**Feed bunker**

16 m deep, 4.3 m wide and 1.1 m high, with a wall thickness of 200 mm. Bunker made of reinforced Besser block.

Shed for whole cottonseed is 4.4 m high, 4.3 m wide and 16 m deep, with reinforced Besser block to 1.1 m, then corrugated iron panels.

**Comments**

Needs a steel post at the end of the wall to reduce damage. Bitumen is in front of the shed and bunkers for wet weather.

High front commodity sheds such as this one in California, are common place in the USA and are built to allow easy discharge of bulk feeds from semi-trailers. The high roof front would only be useful at a low rainfall site. Note the plywood walls set above the 1.5 m concrete walls.

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**Grant and Glenys Currey**

Currey Road
UPPER COOMERA Q 4209
Phone: (07) 5573 1818

Type: Feed bunkers

Year built: 1995

Shed cost: $6250
(without floor)
Molasses storage

R. W. Hodge and Son
(Contact Stuart Hodge)
PO BOX 430
NUMURKAH VIC 3636
Phone: (03) 5862 2407
Cost: $3 000

Pictured are Jeff Andrews and Stuart Hodge

Comments
The molasses is held in an old fuel tank cut in half. Molasses flows via gravity to a 2 tonne underground tank during the day. At loading this steel tank is pressurised with a compressed air hose line and the molasses is quickly loaded into the wagon via a 100 mm pipe. A return line with valve is necessary between the two tanks to vent the small tank during filling. A separate 50 mm water pipe sits above the molasses pipe for adding water to the wagon.

John and Chris Keleher
Keleher Rd
MILMAN
via ROCKHAMPTON Q 4702
Phone: (079) 343 146
Cost: $2 300

Comments
Molasses is gravity fed through a 100 mm pipe from reinforced plastic tanks set above the height of the Keenan wagon. Tank holds 28 tonnes.
Molasses is gravity fed via a 75 mm line into the bottom of the Keenan TMR wagon using standard irrigation fittings. (Larger diameter pipes of 100-150 mm would speed molasses flow, particularly during cold weather).
Silage storage

The best book to read on silage conservation in Australia is ‘Forage Conservation’ by John Moran of Kyabram Research Institute. This provides a comprehensive guide on silage making, silage machinery and storage facilities, methods of feeding as well as the economics of silage making. In this section we have included some photographs of what individual farm managers have built, their dimensions and costs.

Buns

**Dimensions**
80 m long, 22 m wide and up to 4 m high in the middle, holding up to 1100 tonnes of maize silage. The construction cost was $12 per tonne.

**Comments**
Small buns on compacted gravel pads are both cost efficient and generally result in less wastage due to better compaction.

**Eric and Kim Miles**
MS 126
HARRISVILLE Q 4307
Phone: (07) 54671 372

---

**Dimensions**
65 m in length, 10 m wide, and a minimum of 2 m high in the middle. The bun holds corn silage (1000 tonnes), or ryegrass silage (700-800 tonnes). The construction cost was $12/tonne.

**Comments**
These are both good examples of silage buns laid on a compacted gravel pad. The drott (pictured) allows quite high buns to be made by laying silage on and compacting the face without rolling on top, where it is more dangerous.

**Len and Peter Bischoff**
Mt Lindsay Highway
TAMROOKUM Q 4285
Phone: (07) 5544 2296
Feed Pads **DOWN UNDER**

**Colin and Loraine Wright**
Bourkes Road, Gladfield via WARWICK Q 4370
Phone: (076) 661 196

**Dimensions**
50 m long, 15 m wide, and a maximum height of 2 m. The storage capacity is 400 tonnes of maize silage. No cost as the buns are laid on a well drained site.

**Comments**
200 micron silage plastic is used to cover each bun and is held in place using truck tyres.

**Felipe Ribeiro**
Tulare County
CALIFORNIA, USA

This silage bun holds more than 15 000 tonnes of silage on a concrete base.
Bunker silos

Soil sides

Silage pits dug into hillsides are cheap, but soil collapses from the sides and the inability to roll properly on the sides leads to silage loss and mud in wet weather. This invariably forces managers to concrete the sides and bottom.

In wet weather earthen floor pits lead to large losses of silage and great difficulty for the operator to collect silage and it is impossible to keep a clean face.
Cement spray-on sides

Dimensions
42 m long, 7 m at the bottom and 11 m at the top with a height of 2.5 m. The walls are sprayed cement with a thickness of 75-100 mm with a mesh supports at a cost of $4,000 in 1989. The floor slope is 1-2%. The capacity is 800 tonnes of maize silage.

Cement walls

Dimensions
70 m long, 8 m wide, and 2.5 m high, the 2 pits have a capacity of 1000 tonnes each of maize silage. The walls are of pre-cast cement slabs, rejected from commercial building sites. They have a wall thickness of 200 mm on the outer walls, and the inner wall is 150 mm. The supplier was Quickfloor Marsden, Brisbane at a cost of $50,000 ($10,000 for the walls). Construction cost was $25/tonne.
Dimensions
42 m long, 8 m wide, and 2.9 m high with a capacity of 800 tonnes maize silage. The walls and floor are 125 mm thick cement. The cost was $24 000 or $30/tonne.

Comments
Stays - 5 cm pipe, 30 cm in the ground. Posts are made from railway iron and the slabs were poured individually and then tied to the posts with 8 gauge wire. 100 m³ of cement was used. A greater slope is needed to the front of the pit and a cement apron at the front of the bunker would be desirable.

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Lester and Dianne Ballon
MS 501
DALBY Q 4405
Phone: (076) 634 216

Dimensions
40 m long, 7 m wide, and 2 m high, with a capacity of 600 tonnes of silage. The wall thickness is 100 mm. Construction cost was $14 000 or $23/tonne.

Comment
Reinforced concrete slabs (7 mx2 m) poured on site and lifted into position by crane and backfilled with earth. Concrete was 35 mpa and 100 mm thick.
**Feed Pads DOWN UNDER**

**John and Betty Armbruster**  
MS 162 B,  
Junabee  
via WARWICK Q 4370  
Phone: (076) 673 138

Field day at Armbusters, May 1996

**Dimensions**  
25 m long, 8 m wide, 4 m high, with a capacity of 900 tonnes of maize silage. The walls are 150 mm thick, reinforced cement with 5 mm by 150 x 150 mm steel mesh. The walls are supported by earth. Construction cost was $25 000 or $28/tonne.

**Comments**  
The face is too wide for a 60 cow herd.

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**David and Cindy Janke**  
Coopers Rd  
WESTBROOK Q 4350  
Phone: (076) 306 255

**Dimensions**  
66 m long, 6 m wide at the base and 9 m at the top. Capacity is 1200 tonnes of silage. Walls are of reject 200 mm thick reinforced slabs for commercial buildings. The walls are supported by earth and the floor has a slight slope to the front (1 in 100). The pit was built in 1992.

**Comments**  
Should be 50 m long and only 5 m wide for the herd size.

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**Kyabram Research Institute, Victoria**  
(Contact John Moran)  
Phone: (03) 5820500

Cement bunkers such as this cost around $28-34/tonne storage capacity to construct. These bunkers are 25 m long, 5 m wide, and 2 m high with a common wall to the next bunker. They cost about $4 100. Walls and floors are reinforced concrete.
Wooden walls

Dimensions
40 m long, 8 m wide, and 2 m high, with a capacity of 400 tonnes of maize silage. The walls are of wooden split posts. The cost was $4000 for the split posts, or $10/tonne.

Post and weldmesh

A post and steel mesh (7 mm thick with 200 mm squares) silage bunker with earthen floor are cheap ways of storing silage. Construction costs are around $5/tonne storage capacity. Posts need to be a minimum diameter of 150 mm, set 1 m into the ground and 2 m apart. The bunkers are 2 m high and 5 m wide. The sides could also be made from earth. The mesh can be covered with silage plastic before filling.

For information on this system contact John Moran, Kyabram Research Institute (03) 5820500.
### Silage capacities (t) for a 2 m high horizontal bunker

<table>
<thead>
<tr>
<th>Length (m)</th>
<th>Width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>65</td>
</tr>
<tr>
<td>20</td>
<td>130</td>
</tr>
<tr>
<td>40</td>
<td>260</td>
</tr>
<tr>
<td>60</td>
<td>390</td>
</tr>
<tr>
<td>80</td>
<td>520</td>
</tr>
</tbody>
</table>

Assuming density = 650 kg/m³ silage

Capacity (t) = width (m) x average height (m) x length (m) x 0.65

### Commodity bulk densities (kg/m³) for use in bunker design

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>750</td>
</tr>
<tr>
<td>Sorghum</td>
<td>720</td>
</tr>
<tr>
<td>Triticale</td>
<td>720</td>
</tr>
<tr>
<td>Maize</td>
<td>720</td>
</tr>
<tr>
<td>Barley</td>
<td>700</td>
</tr>
<tr>
<td>Oats</td>
<td>600</td>
</tr>
<tr>
<td>Molasses</td>
<td>1400</td>
</tr>
<tr>
<td>Whey (fresh)</td>
<td>1000</td>
</tr>
<tr>
<td>Lucerne (dry)</td>
<td>675</td>
</tr>
<tr>
<td>Malt combings</td>
<td>450</td>
</tr>
<tr>
<td>Whole cottonseed</td>
<td>500</td>
</tr>
<tr>
<td>Cottonseed meal</td>
<td>575</td>
</tr>
<tr>
<td>Peanut meal</td>
<td>650</td>
</tr>
<tr>
<td>Palm kernel expeller</td>
<td>500</td>
</tr>
<tr>
<td>Sunflower meal</td>
<td>550</td>
</tr>
</tbody>
</table>

Doug Maddox, CALIFORNIA, USA

One of the largest silage bunkers in the world with enough room for the bus to do a U-turn on the cement floor. Herd size was around 4 000 cows.
Feedpad design is still in its infancy in Australia. This is not surprising when the inherently pasture-based nature of our industry is considered. Many have strong views about some of the questions mentioned in this book but when closely examined the differences between some of the recommendations are slight and probably will change for feed pads in different regions and when constructed for different purposes.

It seems likely that no one ideal feed pad will emerge. More likely a series of quite different approaches will evolve depending on the purpose for which the pad is constructed, whether the materials are locally available and cheap and the philosophy of the farmer. What ever happens, thenext few years will be exciting as essentially Australian, New Zealand, and South African, feed pad designs are developed.
Further reading


Notes
**Feed Pads**

**Down Under**

This is the most comprehensive book on feed pad design and commodity storage and feeding in the southern hemisphere. It is written by two of the most experienced dairy scientists in Australia - Tom Davison of Keenan, and Jeff Andrews of the Department of Primary Industries, Queensland. It collates their own, and farmers experiences in designing feeding systems for dairy cattle.

**Feed Pads DOWN UNDER features:**

- 145 photographs of feed pads, commodity bunkers, silage and molasses storage systems used on dairy farms across Australia, New Zealand and South Africa, with dimensions and costs.
- Feed pads classified by cost.
- 5 detailed designs for feed and loafing pads.
- 2 detailed designs for commodity bunkers.
- Practical ideas on cleaning feed pads, including flood washing.
- Feed pad designs to cool cows in hot weather.

**Well designed feed pads have the following advantages:**

- Improve cow comfort
- Reduce feed wastage
- Reduce losses through mastitis, hoof and leg problems
- Minimise heat loads and improve cow comfort
- Increase milk yields and composition
- Protect the environment from manure run-off.

This is a practical book for cattle managers who want to cost effectively integrate pastures with silage and commodity feeds.