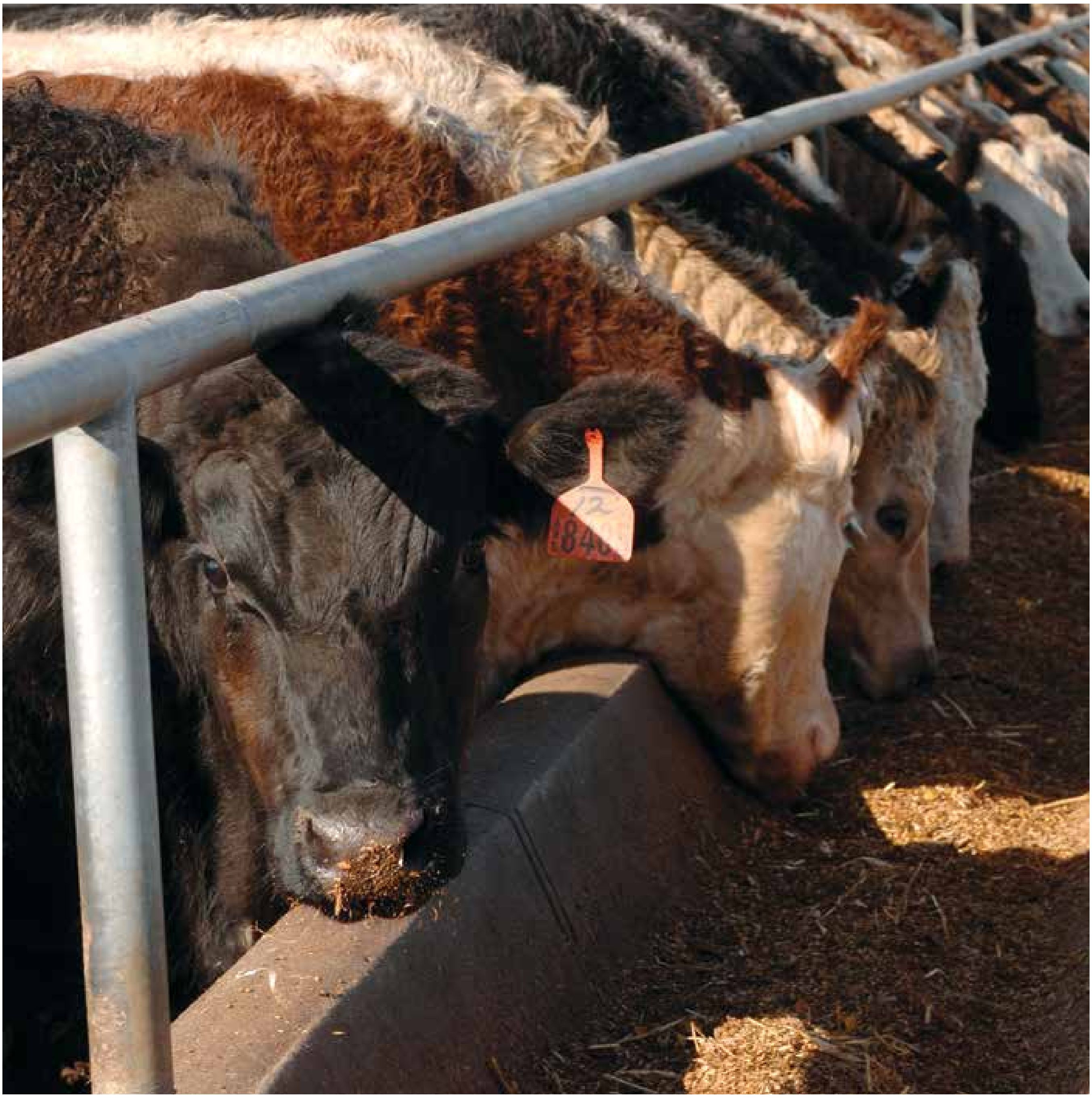
Clean cattle manual



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Contents

1 Introduction and background

The *Clean cattle manual* has been developed by Meat & Livestock Australia (MLA), in consultation with Australian Lot Feeders' Association (ALFA), to provide up-to-date information on management of dags for small, medium and large feedlots.

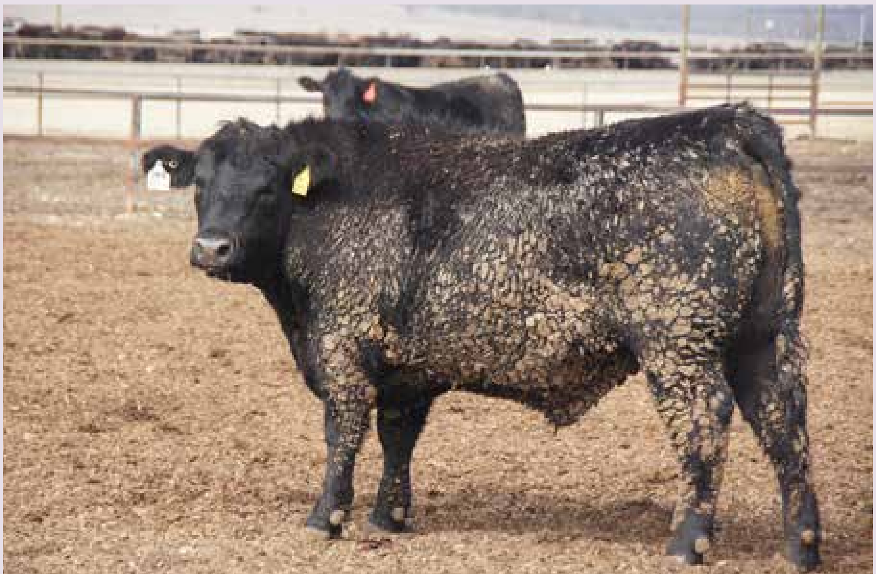
The manual includes case studies which demonstrate how different management practices have been successfully implemented to further assist feedlot managers and staff to make decisions that suit their operation's specific needs.

1.1 Occurrence of dags

Retailers have identified that some of the costs incurred by processors during dag risk periods may be alleviated if increased effort was expended at the feedlot level to better prepare cattle for slaughter.

What are dags?

Dags are an accumulation of faecal and soil particles that adhere to hair in the coats of cattle. They are formed when manure, dirt and hair are bound together with grain sugars and protein residues. As dags dry and become hydrophobic, they become increasingly difficult to remove (Slattery, Davis and Carmody, 2005). Dags tend to accumulate along the belly, brisket, tail, legs and sides of animals, as shown in this image.



Mud and dags on the belly and sides of cattle during prolonged wet pen conditions must be removed before slaughter. Source: Watts et al., (2016).

Dags usually develop in winter in climate zones where high winter rainfall and low rates of evaporation combine to prevent rapid drying out of feedlot pens. This is usually between the months of April and September on the eastern coast of Australia. Dags have been known to occur outside of these climate zones and time periods, but the severity is substantially lower, and there is little, or no management required. For example, feedlots located in central NSW report that dags are a problem for them every winter, but those located in areas dominated by summer rainfall, such as western Queensland, have fewer dag problems because pens generally dry out rapidly following rainfall events (Watts *et al*., 2016).

The incidence of dags can increase from relatively minor to severe, with the worst cases seeing animals carry an average of 3.7kg of dags per animal (Auer, Covington, Evans, Nat & Tozan, 1999). Dags are also more of a problem for longer hair breeds of cattle. *Bos taurus* cattle, which traditionally have long hair coats during winter, are the most commonly affected, although other breeds can also be impacted.

1.2 Impacts of dags

Dags arise in feedlot cattle and present major challenges across the entire beef supply chain due to:

- concerns regarding the welfare and health of animals
- increased costs associated with the cleaning and processing of daggy cattle
- workplace health and safety issues associated with dag removal from live animals
- reduced performance and meat quality outcomes
- the potential to compromise food safety through carcass contamination.

1.3 Pre-slaughter inspection cleanliness requirements

Despite the range of available practices to contribute to dag management at feedlots, abattoirs are still required to wash cattle in accordance with the *AS4696:2007 Australian Standard for the hygienic production and transportation of meat and meat products for human consumption* (Commonwealth of Australia, 2007).

Animals must also pass a veterinarian's pre-slaughter inspection before they can be cleared for slaughter.

2 Solutions for keeping cattle clean at feedlots

There are a range of management techniques available for Australian feedlots to prevent and remove dags. This chapter will explore each technique and their specific advantages and disadvantages.

2.1 Regular pen cleaning

Regular pen cleaning is extremely important for maintaining a manageable level of manure in feedlot pens. It is recommended by the *Beef cattle feedlots: waste management and utilisation handbook* (MLA, 2016) that feedlot pens should be cleaned at least every 13 weeks; however, there is high variation among feedlots, ranging from every 49 days to three times a year.

More frequent pen cleaning, as well as pen cleaning immediately prior to winter rainfall periods, can help to reduce the mud volume susceptible to promoting dag forming conditions. Pen cleaning (including manure collection and handling) is a significant component of any feedlot budget; the necessary equipment and associated staff costs need to be accounted for.

Pen cleaning can be poorly executed as a result of inadequate equipment or operator error. Consequently, the pen surface may be over-excavated, compromising the integrity of the interface layer and pen foundation. Currently, pen cleaning is usually undertaken by feedlot machinery such as by box scrapers, front end loaders, or excavators. As technology improves, there is the opportunity to improve pen cleaning efficiency. Laser levels and RTK-GPS (real-time kinematic Global Positioning System) are two technologies available that could be used to aid pen cleaning operations.

1) Laser levels

Laser levels are limited to operating on pens that have been constructed and (more importantly) maintained with specific pen grades. They have a limited range of operation. If there are humps and hollows in the pens that are to be cleaned, a laser-controlled system cannot be utilised. In addition, there is a limited line of sight. Therefore, the base needs to be shifted frequently from row to row, and even along single rows. Due to these operational constraints, the laser level approach can only be applied to new pens, which is not representative of most of the existing infrastructure in the Australian beef feedlot industry.

2) RTK-GPS

RTK-GPS machine control is a technology used throughout the civil construction industry. The benefit of RTK-GPS for pen cleaning is that a design surface (digital terrain model or DTM) is developed and digitally uploaded. The DTM can have any number of design grades, which is important when considering the foundation of existing feedlot pens that have been cleaned and repaired for any extended period of time.

One limitation of this technology that has been recognised is that the GPS signal can be lost when under or directly adjacent to solid structures, such as corrugated iron shade or covers. However, the signal does pass directly through cloth shades. Despite this limitation, due to the ability to upload design surfaces that contain variable design grades, RTK-GPS machine control is ideally suited for both new and existing feedlot pen surfaces.

2.2 Design, construction and management of pen surfaces

◆ 2.2.1 Design and construction

Various sources of information exist that provide details of measures that can be implemented in the design, construction, and operational phases of feedlots to ensure that drainage and run-off are optimised to reduce the likelihood that excessive muddy conditions will form in feedlot pens after rainfall events (Watts *et al*., 2016). Examples of these measures include:

- pen slopes in feedlots should be greater than 2.5% to promote effective drainage (Watts *et al*., 2016)
- pen surface stabilisation, with further technical information included below.

Pen surfaces can be stabilised with products such as lime and cement mixes. Soil testing needs to be undertaken initially to assess bearing capacity, particle size distribution, and Atterberg Limits. Based on the results of the soil stabilisation testing, soils will be treated with combination mix of lime and cement.

Prior to the cement stabilisation process, general bulk earthworks need to be undertaken. This involves stripping the top 200mm of soil to remove organic matter and conducting cut, fill, and compaction to reach the finished design levels. The soil stabilisation process involves adding quicklime using a spreader. After spreading, water is added (slaking process) to transform the quick lime into hydrated lime, which is blended into the top 200mm of the pen surface. After blending, the surface is rolled out using a roller and trimmed back to the finished design surface using a grader.

After the surface is rolled and graded, the pen needs to be allowed to cure for two days prior to the addition of cement. Cement is applied using a spreader and water again applied to the surface. This mix is then blended to a depth of 200mm, rolled and trimmed using the same process used for the lime.

Upon completion, pen surfaces should be allowed to rest for three months before the addition of cattle.

Blending lime into the top 200mm of the pen surface. Source: Premise Agriculture.

◆ 2.2.2 Management

Appropriate management of pen surfaces can prevent the conditions that lead to the formation of dags (Watts *et al*., 2016). These conditions include:

- imperfections such as weak spots, wet spots and holes should be prevented from forming in pen surfaces
- manure should not be allowed to accumulate in pens for a period of greater than 13 weeks (may be less depending on climatic conditions)
- no areas in the pen should be allowed to remain wet for long periods (such as in winter, under shade, or around water troughs)
- maintenance of the 'manure interface layer', an impermeable layer about 50mm deep that consists of mixed compacted soil and manure
- mounds of bedding or surface material can be used to provide dry-lying areas in pens (Tucker *et al*., 2013).

2.3 Pen surface bedding solutions

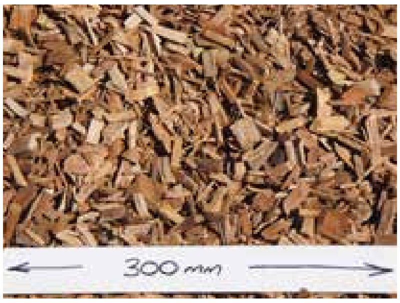
Feedlot bedding may reduce the impacts and development of dags by absorbing moisture from cattle manure and mud and preventing it from sticking to animals and initiating dag formation.

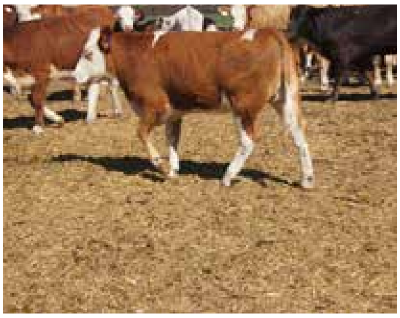
Bedding materials can be applied before or after rainfall events and should be continually added to the pen over time, as required. Depending on your geographical location and the type of feedlot you have (covered or uncovered), the viability of using feedlot bedding in your feedlot will need to be considered. Rather than using it in all pens, you may consider using it in the post-washing pens, hospital pens and/or dispatch pens only. Bedding viability for cattle in southern Australia is being investigated.

Table 1 provides a brief summary on bedding materials available, their use and effectiveness, advantages and disadvantages, availability in Australia and costs.

Table 1: Bedding materials available in Australia. Source: Watts *et al*., (2015).

Bedding material	Use and effectiveness	Advantages and disadvantages	Availability	Costs ($AUD)
Sawdust 	Widely used Quickly becomes part of the mud and manure layer, which reduces its effectiveness Needs to be replaced approximately every 3 months See case studies on Feedlots B and C for their use of sawdust	**Advantages:** • Easy to handle • Highly absorbent • Provides animal comfort and dag reduction • Reduces odour • Provides good pen surface protection **Disadvantages:** • Can be moulded and shifted when force is exerted • Poor durability • Poor porosity • No recyclability	By-product of timber industry, therefore readily available in timber producing and/or processing areas	$4.50–$11/m^3; $45/t Transport can be expensive due to low bulk density (~160–300kg/m^3)
Rice hull/husk	Produced in the first step of the rice milling process when the husk is removed from the grain Quickly becomes part of the mud and manure layer, which reduces its effectiveness	**Advantages:** • Water and fungus resistant • Excellent thermal insulator • Good porosity **Disadvantages:** • Difficult to handle • Can blow out of pens when dry • Low moisture retention capacity • Poor durability • No recyclability	Available to feedlots in close proximity to rice mills	$67–$90/m^3; $627/t Transport can be expensive due to low bulk density (~70–145 kg/m^3)

Bedding material	Use and effectiveness	Advantages and disadvantages	Availability	Costs ($AUD)
Timber harvest residues 	Residue from timber harvested in the forest such as bark, leaf, branch strippings and stripped tree tops.	**Advantages:** • May aid composting process • Provides comfortable lying conditions • Good absorbency and porosity **Disadvantages:** • May produce splinters • Can only be used once • Poor durability • Poor recyclability	By-product of timber industry so available in timber producing and/or processing areas	$11–$17/m^3 Transport can be expensive due to low bulk density
Timber off-cuts 	Off-cuts from timber processing, typically 300mm long and 150mm wide	**Advantages:** • Good durability • Good porosity • Good recyclability **Disadvantages:** • Off-cuts are uncomfortable to lie on • Poor absorbency	Limited market Limited availability Firewood could be used but this increases costs	$56–$90/m^3 $39–$45/t
Wood chips 	Produced at timber mills and during tree disposal Typically 25mm in length See case study on Feedlot C for their use of wood chips	**Advantages:** • More durable than straw and sawdust • Porosity lasts longer than a straw or sawdust bedded area • Larger wood chip pieces can be recycled (i.e. screened from spent bedding) • Easier to handle, transport, distribute, and remove from pens than straw • Provides animal comfort and dag reduction	Generally available from timber mills; however, demand is high and usually exceeds supply	$17–$48/m^3 $56–$90/t

Bedding material	Use and effectiveness	Advantages and disadvantages	Availability	Costs ($AUD)
Wood chips (cont.)		**Advantages:** (cont.) • Reduces odour • Absorbent • May reduce dust **Disadvantages:** • Demand (for landscaping, paper production, and bioenergy) usually exceeds supply • Poor recyclability		
Wood mulch  	Produced when wood by-products are processed in a tub-grinder rather than a wood chipper Consists of shattered and broken splinters rather than uniform short chips	**Advantages:** • Provides animal comfort and dag reduction **Disadvantages:** • No re-useable product can be recovered	Good availability from timber mills/ landscape suppliers	$17–$56/m^3 $118–$560/t
Straw 	Commonly wheat or barley straw but other sources available (i.e. corn stalks) Longer straw particles create a stronger, more durable bedded area that allows better drainage than chopped straw	**Advantages**: • Highly absorbent • Provides animal comfort (considered better than wood chips) • Can be continually added to pen over time • May reduce odour • May absorb volatile organic compounds allowing their removal from pens (preventing their run-off) • May reduce dust • Can delay run-off	Good unless drought conditions are causing low supply	$11–$13.50/m^3 $78–$168/t

Bedding material	Use and effectiveness	Advantages and disadvantages	Availability	Costs ($AUD)
Straw (cont.)		**Disadvantages:** • Has to be regularly replaced (Every 28 d) • Cattle may eat the bedding • Unsuitable for recycling • Average durability		
Almond hull	Separated from shell and nut during processing Widely used as animal feed and bedding in the United States Quickly becomes part of the mud and manure layer, which reduces its effectiveness	**Advantages:** • May be cost effective in some regions **Disadvantages:** • Poor absorbency, durability and recyclability • Does not reduce dags • May be considered palatable by cattle	Availability and uptake limited by processing locations in north-west Victoria and NSW Riverina.	N/A
Composted manure	Considered similar to sawdust as a soft flooring in concrete pens	**Advantages:** • Highly absorbent **Disadvantages:** • Turns into a soft manure slurry that can be moulded and shifted when force exerted • Composition varies depending on the properties of the raw manure • Cattle become dirty	Readily available within feedlots	Negligible (management only)

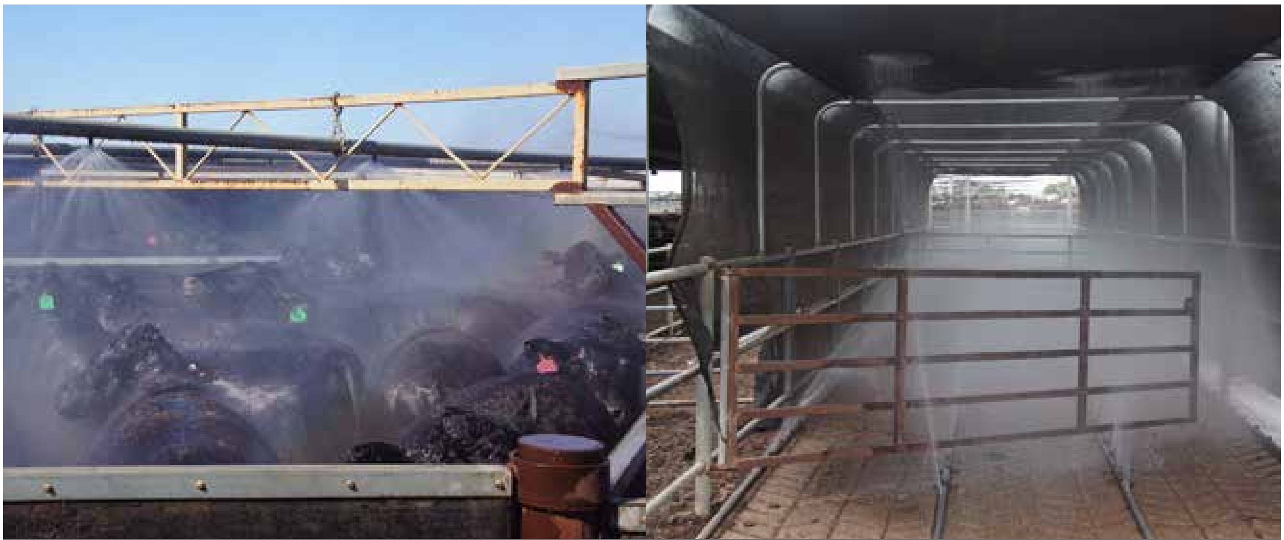
Bedding material	Use and effectiveness	Advantages and disadvantages	Availability	Costs ($AUD)
Sand	Used in free stall dairies and saleyards in Australia.	**Advantages:** • Provides animal comfort • See case study on Feedlot A for their use of sand in their post-washing pens **Disadvantages:** • Surface can become heavily manured in a short time frame • Can prevent drainage • Low porosity of fine screened sand • Hard to recycle unless washed • Can be abrasive on soft hooves	Readily available when in proximity to sand quarry	Expensive to transport due to high bulk density
Recycled rubber chip	Little research on use in feedlots but used widely in dairy industry (recycled tyres are used to create rubber matting)	**Advantages:** • Longevity • Provides animal comfort **Disadvantages:** • Heavy metal content (i.e. zinc and lead) has potential to compromise animal health and food safety; further investigation required • Limits options available for spent bedding	Can be sourced from car tyre recycling centres	N/A

2.4 Cattle washing

◆ 2.4.1 Infrastructure requirements

Spray pipes for cattle washes should be located on the floor, recessed into the floor, or installed on the sides or above washing facilities (Watts *et al*., 2016). This is to ensure that the most dag-susceptible areas of the animal, as well as processor cutting lines, can be accessed.

Washing can be followed by waterless removal of dags, using mechanical means such as combing, shaving, or clipping. This is usually carried out manually and can be dangerous for operators if animals are not adequately restrained (such as in a crush).



Examples of soaking yards. Source: Watts et al., (2016).

Cattle wash water can be recycled (Watts *et al*., 2016). However, due to risk of cross-contamination, recycled water is only used for the initial soaking period, with clean water required for the high pressure wash. Water treatment can improve the quality of recycled water used for cattle washing. Furthermore, ozone-treated water has increased oxygen levels, which increases the number of possible chemical reactions, and, therefore, can improve dag degradation and release from the hair.

To prevent dags from building up again prior to dispatch for slaughter, washed cattle are sometimes held in post-wash pens (van Moort *et al*., 2018). For maximum effectiveness, these pens should be clean, roofed, and the pen surfaces covered with a bedding material such as wood chip. Resting in post-wash pens for 1–2 weeks prior to dispatch allows cattle to overcome any impacts of washing induced stress on meat quality.

◆ 2.4.2 Washing times – soaking and high pressure

Feedlot cattle washing involves a soaking period to soften dags followed by a high pressure spraying period to remove softened dags (Greenwood, House and Fell, 1998; Haines *et al*., 2000).

The soaking period involves a low pressure, high volume spray and is carried out over an extended period, which can be up to eight or nine hours in extreme cases. Soaking aims to soften dags, mud and dirt and to wash loose manure and dirt out of the coat.

The high pressure washing period is undertaken using high or medium pressure, low volume spray and is carried out over a shorter period (30–60 minutes). The aim of the high pressure wash is to further soften dags and remove them from the coat.

◆ 2.4.3 Water and energy requirements and animal welfare concerns

Washing of cattle is the second highest user of water in feedlots in the months when it is undertaken (Watts *et al*., 2016). The volume of water used for washing cattle at feedlots is variable depending on the size of the feedlot, the extent of dags, whether the washing is automated or manual, and the type of washing infrastructure available.

Previous studies have shown that the water used in cattle washing at Australian feedlots is about 3.5% of total water usage. While average water usage for washing has been found to range from 700–2,500L/head/year, a monthly average water usage up to 3,500L/head has been recorded.

For feedlot planning and design considerations, 1.2L/head/day is often used to approximate the water requirement by feedlots for cattle washing (Davis & Watts, 2011). Costs of water vary depending on flow rate, holding periods, proportion of stock requiring washing and the ability to use recycled water.

In addition to the high volumes of water that are used for cattle washing, there are other disadvantages associated with this method. Soaking and high pressure spraying can lead to animal health and welfare issues due to stress, particularly during cold weather. Similarly, long periods of time between soaking and removal of dags can result in cattle losing significant heat (Watts *et al*., 2015). If this occurs too soon before slaughter, carcase value can be reduced by dark cutting. This can be prevented if resting is allowed after washing to remove dags, but not if further dag formation occurs in the post washing holding pens.

◆ 2.4.4 Costs

The high pressure washing process can take several hours and requires direct intensive inputs of labour, energy and water that are costly to feedlot operators. Construction and implementation of washing infrastructure and other inputs such as bedding and coverings for post wash pens can also be associated with high capital and ongoing costs.

Cost estimates collated from currently operating feedlots for costs associated with cattle washing are shown in Table 2. Further information can be found in the case studies for Feedlots A and C for their individual circumstances.

Table 2: Cost estimates for costs associated with cattle washing.

Costs	Small feedlot	Large feedlot
Initial infrastructure	Minimal – feedlot already had the cement pad for the wash bay, the crush and post-washing pens for other tasks	A generator to power the cattle wash facility = $200,000 The washing facility itself was approximately $800,000–$1,000,000 to construct The post-wash pens would also be a capital expense if they did not already exist.
Washing costs	One person is able to clean 106 cattle in one day; therefore, at an hourly rate of $35, labour costs are $2.64/head Increased water usage and electricity to run the pump are acknowledged and increase with severity of the season	Washing costs approximately $50,000/year. In a bad season, two people would be required for five days a week at eight hours per day. In the worst case scenario, the water requirement is 1ML/day for five days a week for six months. The cost of water is approximately $100/ML.

2.5 Chemical and enzymatic treatments

Chemicals have been trialled for their effectiveness at preventing or removing dags. For example, using detergents while washing dags can help break down dags more effectively and is considered to be a low-stress option (Rowland, Phillips and Coates, 1999). However, the limited observed effectiveness of this method means that it is not widely used.

Chemical products for dag removal can be used during washing or prior to slaughter. Chemical products that have been tested include:

- sodium hydroxide
- trisodium phosphate
- acidified chlorine
- phosphoric acid (Meat Industry Services, 2006).

Enzymatic prevention or removal of dags, if effective, is considered to pose considerable benefits to the feedlot industry. However, to date, no fully successful trials of the use of enzymes have been completed. An enzymatic treatment acts by breaking down the dag-hair bond. A treatment which could be applied via a hose system onto live animals would be most beneficial. At the time of this manual's publication, MLA was working with enzyme manufacturers and testing organisations on some products that have been successfully trialled in New Zealand. However, there have been difficulties getting the use of these enzymes approved in Australia.

An investigation of the effectiveness of enzymes for removing feedlot dags was conducted in 2005 (Slattery, Davis and Carmody, 2005). The findings of this study were that cellulase, together with a dilute salt solution, increased the efficiency of dag decomposition more than laccase and xylanase. A follow-up study was conducted in 2009 (Cassells and Haritos, 2009). The delivery mechanism for the enzyme solution investigated in this study consisted of mixing solutions of commercially available enzymes with a gel which would hydrate the dags, assist enzyme activity, and hold the enzyme close to the dags. The study found that, contrary to findings of the 2005 study, the addition of enzymes did not improve ability to remove dags from hair. Reasons put forward for this were that dags are variable and those that are dry, hard, and water repellent, will be very difficult to remove under any circumstances.

2.6 Manual and mechanical methods of dag removal

Removal of dags from live cattle using mechanical and manual methods is also possible. However, this form of dag removal is more time consuming than washing and can be associated with excessive workplace health and safety risks due to the potential for human injury. In general, manual and mechanical systems can only be implemented where a crush is available to ensure cattle can be adequately restrained.

◆ 2.6.1 Rockdale De-dag Machine (RDDM)

The RDDM was developed as an alternative to washing and can clean approximately 35 cattle an hour. It uses rotating cleaning drums and robotics to remove dags from dry cattle.

The RDDM was found to be an effective means of removing wet or dry dags; however, the high capital cost of the machine precluded its adoption by industry. The capital cost of the initial prototype was recorded to be $500,000. If interest and depreciation are not included, the cost per head of de-dagging using the RDDM is $4.22, as per MLA final report Research, Development and Commercialisation of the Rockdale Dedag Machine (Paradice, 2000). This per head de-dagging cost includes labour, machine maintenance, power and rice hull bedding. Although initial studies have shown that use of the RDDM does not result in undue stress in cattle, it is advisable that the levels of stress in animals cleaned with the RDDM be further investigated.

The effectiveness of dry dag removal by the Rockdale De-dag Machine. Source: Paradice (2000).

2.6.2 Shearing or Clipping

It is possible to shear or clip cattle to remove dags. An example of a shearing system is the Parke Rota Shear (Greenwood, House and Fell 1998). This is an air-driven handpiece which can be used pre- or post-slaughter to shear dag risk areas. It is reported to be an effective method, despite uneven hair combing, which can impact tanned hide quality. Greenwood, House, and Fell investigated the effectiveness of shearing in relation to a range of other pre- and post-slaughter dag removal techniques (including the Parke Rota Shear and RDDM). Similar to the RDDM, this study found that shearing did not result in undue animal stress; however, the risk to human safety was deemed to be substantial. The study concluded that shearing was the only technique that totally eliminated dag loads. Apart from the expected initial infrastructure (crush and post-shearing pens) and ongoing labour costs, shears or clippers have a low capital and ongoing maintenance cost.

In the United Kingdom, where intensively produced cattle are generally housed in covered yards, clipping is a recommended measure to prepare cattle for slaughter (Food Standards Agency and ADAS, no date). Clipping is carried out on finishing cattle and involves clipping approximately 5cm each side of the spine to reduce sweating and the risk of wet dirty hides. It is necessary to also trim dirty hair on the belly and flanks prior to slaughter.

2.6.3 Combing

Some feedlots, such as one of the participants in the case studies included at the end of this manual, use a metal comb to remove dags after the soaking period. The case study participant noted that the comb is low cost and effective at removing dags; however, there are additional costs associated with labour required to carry out the washing, soaking and combing and a health and safety risk to the operator.

2.7 Covered pens

Partial or full feedlot pen covering, in conjunction with the use of bedding, can overcome the development of dags. This is due to the decreased volume of rainfall that enters the feedlot pens and the reduced build-up and retention of wet and muddy pen surfaces.

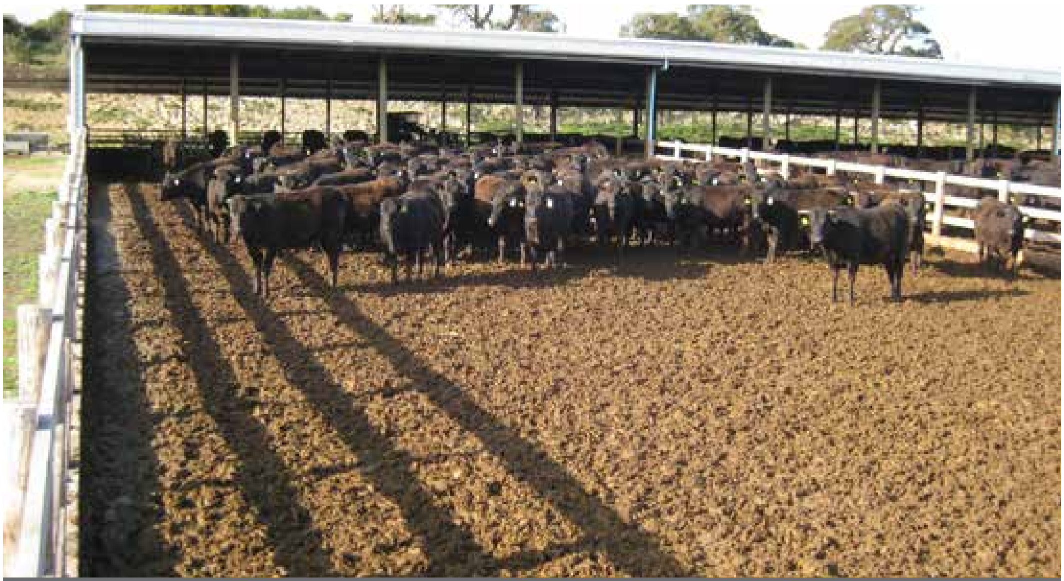
2.7.1 Partially covered

Partially covered lot design provides a roofed area over the feed bunk and up to a third of the pen. The covered area at the top of the pen requires some form of bedding to prevent potential hoof problems. The bottom of the pen is then operated as an open lot.

Partially covered pens can be designed to allow cattle to be enclosed under the roofed area during wet conditions and allowed into the open lot area during dry periods. Stocking density under the roofed area should be retained between 4 and 8 m2/head and when the pens are open, an open feedlot stocking density of between 12 and 15 m2/head would ensure full use of the pen area.

Water from the roofed area must be collected via a gutter to prevent pen degradation. The harvested water can be used to supplement drinking water supplies.

While a sedimentation basin and effluent holding pond are still required for partially covered pens, the sizes of the ponds can be substantially reduced due to much reduced effluent runoff loads. Unlike fully covered sheds (discussed below), there is no impediment to airflow in partially covered structures.


A partially covered (skillion structure) feedlot pen.

◆ 2.7.2 Fully covered

Fully covered feedlots are operated in areas of particularly high rainfall (such as South-East Asia) or in areas of snow (such as the United Kingdom, United States and Canada). Fully covered feedlots are also starting to become popular in Australia, and many have been, or are soon to be, constructed in South Australia, Victoria, and Queensland. Advantages associated with fully covered systems include:

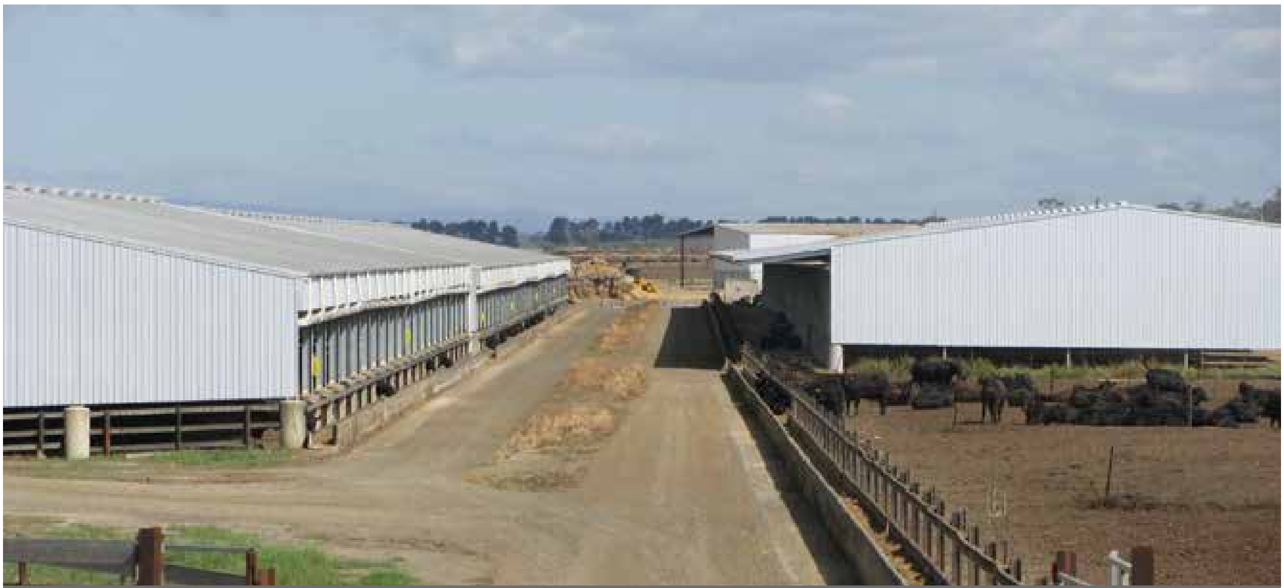
- reduced facility footprint through increased stocking densities
- eliminated rainfall onto to pen surface and, consequently, the need for any effluent ponds
- provision of shade year-round
- increased airflow if located appropriately
- with the use of bedding, increased animal performance.

Capital costs of the fully covered system can be high (compared to open and partially covered feedlots). Furthermore, the addition of bedding (straw, sawdust, sand, woodchip or similar) every six to eight weeks increases operational costs and labour requirements. Slatted floors is an alternative option in a fully covered operation, although animal comfort needs to be considered if concrete slatting is utilised (rubber slatted floors, or rubber matting over the concrete floors, are options to provide greater animal comfort).

Two main designs exist for covered feedlots:

1. Hoop barn structures, which are constructed with hardstand bases of either stabilised soil or concrete, with timber or steel perimeter frames. The frame is covered with a long-lasting high-density poly ethylene liner.
2. Steel framed sheds, which are also constructed with hardstand bases. Depending on the design this can be a skillion roof or A-frame shed design.

The shed system can be designed with either a central cattle lane or central feed road. For both design options, gutters are required to capture roof runoff, which can be used to supplement drinking water supplies. Regardless of which facility is developed, the cattle should be stocked at 4–8m^2/head and bedding must be supplied.


Covered feedlot with an A-Frame roof.

2.7.3 Costs

Cost estimates collated from currently operating feedlots for costs associated with covered pens are shown in Table 3. Further information can be found in the case study for Feedlot B.

Table 3: Cost estimates for costs associated with covered pens.

Costs	Small feedlot	Large feedlot
Partially covered	Approximately \$60–70/m^2, which includes shed structure only, no additional associated infrastructure or works	Costs reduce as size of feedlot increases
Fully covered	Approximately \$1,000 per standard cattle unit	Costs reduce as size of feedlot increases

3 Case studies

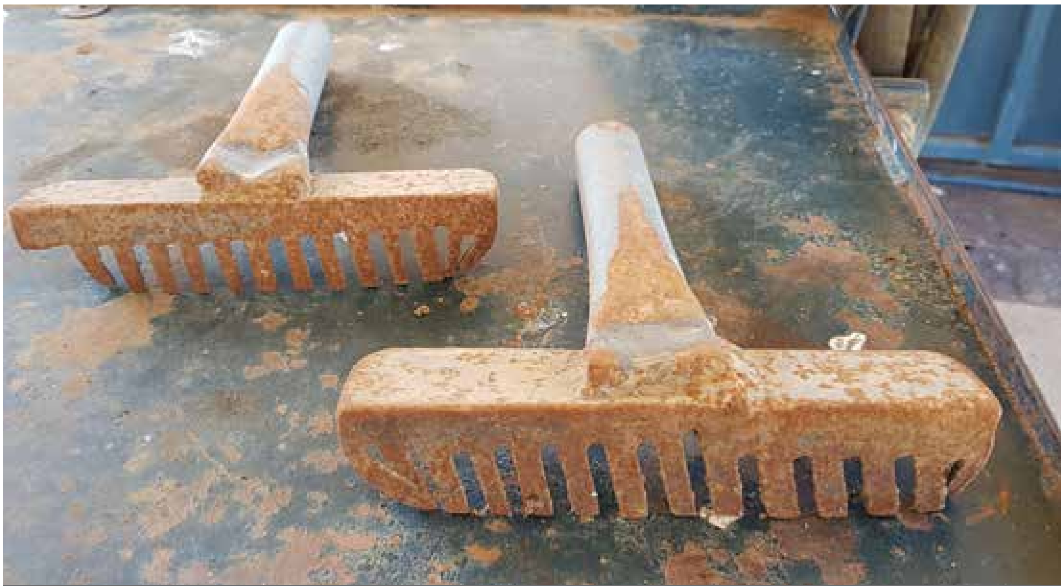
Interviews were conducted with feedlot operators who have implemented strategies that reduced dag severity of cattle dispatched to processors in dag-affected locations.

3.1 Feedlot A: Dag combing and increased pen management at small feedlot

Feedlot A is located in south-east Queensland. It has a capacity of 1,000 head (stocking density of approximately 13.5m^2) and is planning an expansion to 2,500 head in the near future. Currently Feedlot A has a throughput of approximately 6,000 cattle/year.

The dag risk period for the feedlot is between April and September. During this time, approximately one third to one half of all cattle are impacted by dags, depending on how wet the winter is.

Feedlot A uses a comb to manually remove dags from impacted cattle. The combs were designed and manufactured by Feedlot A. They are a piece of steel approximately 200mm long with 3mm grooves, similar to a horse curry comb (see image).



Combs used at Feedlot A for dag removal.

Feedlot A's dag management method involves soaking cattle for at least 20 minutes in a wash bay that holds 23–25 head of cattle. Soaking is followed by combing the cutting lines (underneath and sides of the cattle). During combing, cattle are held in a full hydraulic crush. The crush holds the head and has openings at the bottom and both sides to allow access to the dag impacted areas. Following combing, if dags still remain on the cattle they go to a sand bedded pen. If the cattle have no dags after washing, they go back to their normal pen. The washing occurs about 10 days prior to dispatch.

Feedlot A dispatch 56 cattle one week, and 159 the next; on average, around 106 cattle a week. If it is a wet winter resulting in increased dags, it will take one person one full day to clean 106 cattle (this includes moving the cattle from their pens to the wash bay, washing, combing and returning the cattle to their pens).

Feedlot A implements increased pen management activities during the dag risk period, to assist in reducing the reliance on combing to remove dags. A pen scraper piles the manure and a bucket removes it from the pen. Feedlot A also cleans the water trough and feed bunk aprons more frequently during winter.

The advantages and disadvantages of dag management at Feedlot A are listed in Table 4.

Table 4: Advantages and disadvantages of dag management at Feedlot A.

Advantages	Disadvantages
The material costs associated with making the combs are minimal (approximately $10), plus a small amount of labour to manufacture.	Washing-related costs (labour and water): • Based on being able to soak, wash and comb 53 cattle in four hours at an hourly rate of $35, labour costs are $2.64/head. • Additional maintenance that takes place during the dag risk period can be costly. While overall the same volume of manure is probably removed annually, in winter it needs to be removed more regularly. In the non-dag risk period, pen cleaning is carried out every eight weeks, but in winter it is up to once a month, depending on the volume of rain. There are costs associated with water use. Water use increases with the severity of the wet winter period.
Power costs associated with the wash bay are minimal; the pump used is not very big and it does not pump for long periods of time.	Animal welfare: Cattle do not seem to become stressed by the soaking and combing; however, a decreased intake following the procedure has been observed. If intake reduces to a point above feed required for maintenance, weight will still be gained, although reduced. If intake reduces to a point below the feed required for maintenance, animals may even lose weight. Either of these outcomes are costly to the feedlot.
The feedlot already had the concrete pad for the wash bay, and the crush and sand-bedded pens are all used for other tasks, not just for cattle washing, so the associated infrastructure costs are seen as minimal.	Health and safety risks: There are health and safety risks to the operator by carrying out the combing procedure as it is seen as a high risk activity. However, Feedlot A rarely has any dag washing related injuries, as staff are cautioned to be very careful.

Overall effectiveness

Feedlot A considers the combing system, combined with increased pen management, to be very effective. The feedlot is penalised $3–5/head by the processor for dirty cattle that require additional washing to meet compliance with AS4696:2007.

If no washing or combing is carried out, up to half of the cattle (depending on the severity of the wet winter and the type of cattle) will incur the additional $3–5/head charge for additional washing requirements. However, if washing and combing is carried out, the feedlot usually receives no penalty from the processor, indicating that cattle do not require extra washing.

3.2 Feedlot B: Covered pens at small feedlot

Feedlot B is a completely covered feedlot located in South Australia. It has a current capacity of 400 head (stocking density of approximately $4m^2$) and is currently seeking approval for an expansion to 4,500 head. Feedlot B has a throughput of approximately 750 cattle a year. The dag risk period for the feedlot is between May and September.

The covered feedlot design includes two sheds, each 30m wide x 50m long, with four 20m x 10m pens in each shed. Each shed holds 200 cattle.

Due to the very high rainfall in the region, the feedlot was designed and constructed as a covered feedlot, not directly to control dags, but primarily to ensure good cattle foot health and to minimise effluent management requirements. However, because of the reduced rain impact, the feedlot is not susceptible to the levels of built-up mud that open feedlots are susceptible to in high rain periods. This has substantially reduced the impact of dags, which would be expected to affect 100% of cattle in an uncovered feedlot in the same area. Feedlot B do not undertake any additional dag management practices.

Sawdust bedding is used in each shed which is sourced from a local timber mill. The feedlot is in an area where timber is the primary industry outside agriculture. The composted sawdust waste is spread, using Feedlot B's compost spreader, onto their own property and also sold off site. They also lease the spreader to people who purchase the compost.

The advantages and disadvantages of dag management at Feedlot B are listed in Table 5.

Table 5: Advantages and disadvantages of dag management at Feedlot B.

Advantages	Disadvantages
Feedlot B is not burdened with any additional labour or costs for dags management. As part of their existing bedding routine, Feedlot B replaces the bedding every six weeks, and this involves an additional truck driver.	Infrastructure: Capital costs for covered feedlots can be high depending on the design and style of the shed and the need to incorporate different climatic requirements (such as ventilation and fans or other cooling systems). To date, costs for Feedlot B have been approximately $1,000 per standard cattle unit.
Waste management is a profitable part of the business, rather than a cost. Feedlot B currently sell their sawdust waste product for the same cost as what they pay for the original sawdust. There are interest payments and lease payments on the spreader, but these are offset by the income they receive from people purchasing the sawdust compost and leasing their spreader.	
There is very little maintenance of the sheds themselves. The feedlot uses solar power and generators, so there are no additional power costs for the sheds.	

Overall effectiveness

While not the original intention, the sheds substantially reduce the incidence of dags at Feedlot B. The operator believes that it is the bedding which causes the dags or dirtiness at Feedlot B. The dag residue is only on the back legs and the underbelly, not up to the spine.

Specific dag management practices have never been in place at Feedlot B, and the feedlot has not been penalised, until just recently, for having dag-impacted cattle (Feedlot B was charged a single cleaning fee of $200 across a load of cattle). This may have been due to cattle being “dirty” rather than “daggy”. The operator was of the belief that any dags that are present, dry and break off in the period between yarding, transport, and pre-slaughter inspection.

3.3 Dag management plan at large feedlot

Feedlot C is located in NSW and has a capacity of 32,000 standard cattle units and a throughput of approximately 45,000 cattle a year. The dag risk period for Feedlot C is between April and September. All cattle are impacted by dags during this period.

The dag management plan employed at Feedlot C is multi-faceted and involves a maintenance and cleaning regime as well as defined cattle washing process.

Prior to washing, cattle are put in pens bedded with 150mm wood chips. The period of time spent on woodchip depends on the cattle type, as follows:

- long-fed – at least 100 days
- short-fed – one to two weeks
- Wagyu – one month.

The primary purpose of the wood chips is to increase the health of the cattle. It is found that there are less morbidity and mortality problems due to casting and foot hygiene problems on the wood chips and that there is an equal or better feed intake in wet weather. The sharp edges on new wood chips can help to manually remove dags; however, the sharp edges are smoothed out relatively quickly and the wood chips need to be replaced every month.

The cattle washing process is conducted in a covered wash facility and is carried out only during the dag risk period. Washing is carried out two weeks prior to slaughter. First, the cattle undergo a soaking cycle, with the period of time depending on the dryness of the dags. Dryer dags require a longer period of time to allow the water to penetrate and soften the dags prior to removal. In general, it is a 30-minute soak, 30-minute rest and 30-minute soak cycle.

Following the soaking period, cattle are washed with high pressure sprays (600psi) that are directed to the dag prone areas (belly and legs) and cutting line areas of the cattle. The high pressure wash lasts for five minutes and is usually carried out twice. A high pressure hose is used to rinse and remove remaining dags following the high pressure wash cycles.

Following the washing cycle, cattle are kept on sawdust in covered sheds to allow them to recover from the washing in an environment that will prevent the re-occurrence of dags.

The advantages and disadvantages of dag management at Feedlot C are listed in Table 6.

Table 6: Advantages and disadvantages of dag management at Feedlot C.

Advantages	Disadvantages
There is no lost opportunity as a result of having the covered post-washing sheds, because these are used year-round to feed cattle.	Infrastructure: • A generator was purchased for $200,000 to power the cattle wash facility. • The washing facility itself cost approximately $800,000–$1,000,000 to construct. • The post-wash pens would also be a capital expense, but these existed prior to the development of the cattle wash. • Wood chips are replaced every four to six weeks for a cost of approximately $10,000. • The cost of sawdust is $55/tonne and there are 2.5m^3 to a tonne. Approximately 55t of sawdust is used every six weeks (240 cattle, 42 days, 10,080 beast days). This equates to 30c/head/day not including labour.
	Washing-related costs (labour and water): • The operator reports that washing costs approximately $50,000/year. • In a bad season, two people would be required for five days a week (eight hours at $30/hour) to conduct cattle washing. • In the worst case scenario, the water requirement is 1ML/day x 5 days a week for six months. No recycled water is used due to the age of the infrastructure in the washing facility. It is estimated that improvements to this infrastructure, to allow recycled water to be used in the wash, would cost approximately $5 million. The cost of water is approximately $100/ML.
	Health and safety risks: • The facility is designed to benefit worker safety. • Workers at Feedlot C take normal precautions while operating the facility.
	Animal welfare: • A decreased intake following the washing procedure has been observed.

Overall effectiveness

Feedlot C reports that approximately 20–25% of dags are removed by using their dag management plan. However, this operator draws a distinction between cleanliness and dagginess; Feedlot C believes that cattle can be 100% clean, but still have dags.

No stock from Feedlot C has ever been sent back from the processor and no penalty has been incurred by Feedlot C due to dagginess. However, on occasion, the feedlot has had to send staff to the processor to wash cattle that are assessed as being daggy.

4 Conclusion

This Clean cattle manual has examined dag management techniques that can be utilised at the feedlot pre-slaughter to manage dag load on cattle before they arrive at abattoirs. It is recommended that each individual feedlot considers their own unique situation before implementing any specific, or range of, management strategies. Worker safety and animal welfare is also imperative and should be given the necessary consideration before a management technique is implemented.

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