Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

SA DROUGHT HUB

CONTAINMENT FEEDING TO BOOST BUSINESS PERFORMANCE AND RESILIENCE PROJECT

PRODUCER RESOURCE GUIDE

Draft Version: January 2023

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This program received funding from the Australian Government's Future Drought Fund

Acknowledgments
The Producer Resource Guide was developed to support advisor training within the Containment Feeding to Boost Business Performance and Resilience Project.

This project has been made possible through funding from the SA Sheep Industry Fund, the SA Drought Hub, and contributions from all the participating Drought Hubs and farming systems groups across South Australia, Victoria, Tasmania, and Southern NSW.

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INTRODUCTION

Containment feeding is a good option to allow stock to be successfully supplementary fed while maintaining paddock condition.

Over the break of the season while waiting for pasture growth, removing grazing pressure can allow pastures to get ahead of stock and provide adequate feed on offer for lambing. Removing stock off paddocks in dry times also allows high reserves of dry feed to be retained, enabling adequate ground cover, reducing erosion risk and improving pasture recovery after a break.

During times of inadequate pasture, stock will often cover a large distance trying to reach their nutrition targets, deteriorating paddock condition further while also walking off an extra 2 to 3 megajoules of energy (dependent on paddock size). Feeding in containment can result in a lower energy requirement to maintain condition due to less energy wastage associated with the unnecessary walking.

When supplementary feeding is required the time and cost saving of having stock in containment and all fed in one area can also be substantial.

The common positives and negatives associated with containment are listed in the box to the right.

This resource has been prepared to use as a technical guide for producers seeking to include best practice containment feeding in their sheep enterprise. It is important to note that this resource is to be used as a guide only and producers should apply local and regional knowledge in decision making and implementation of containment feeding, as well as seek further information and expertise where required.

Common positives and negatives associated with containment

POSITIVES

Can maintain ground cover above targets in pasture paddocks.

Maintain ewe condition in a controlled environment.

Reduced time, labour and diesel cost when supplementary feeding ewes in one area.

Can get increased lambing results associated with more precise management and condition score of ewes.

Additional feed on offer at lambing associated with higher lamb survival.

Useful pens for other purposes i.e. holding stock around shearing times, quarantine pens and finishing lambs.

Reduces stress as there is a feeling of control in dry times.

NEGATIVES

If feed change is too abrupt can get a ‘break’ in the wool fibre.

Feed management needs to be precise.

Potential to increase health problems if not managed correctly.

Cost of infrastructure.

DECISION MAKING PATHWAYS, TOOLS AND MATRICES

Farmers will confront multiple decision points before they start containment feeding. Some are relatively simple; some are more complex.

Relatively simple decisions only have one or two overriding critical factors that demand thought. They can be processed easily in the head and a 'no brainer' decision applied. In a containment context these include decisions around paddock water or suitability of stock to enter containment.

Complex decisions have *multiple critical factors*, which commonly have *different levels of importance*. Also, each of these critical factors will have *tipping points*, where people think differently. For example, if the cost of feeding was a critical factor to consider, you may think differently if the cost was anticipated to be $10/head or $100/head. Trying to process these combinations in your head is challenging.

Details and steps to create a decision matrix are provided in appendix 1. It is recommended that producers work through the development of a decision matrix with their trained advisor, or attend a containment feeding decision making workshop aligned with this project.

Decision matrix concept

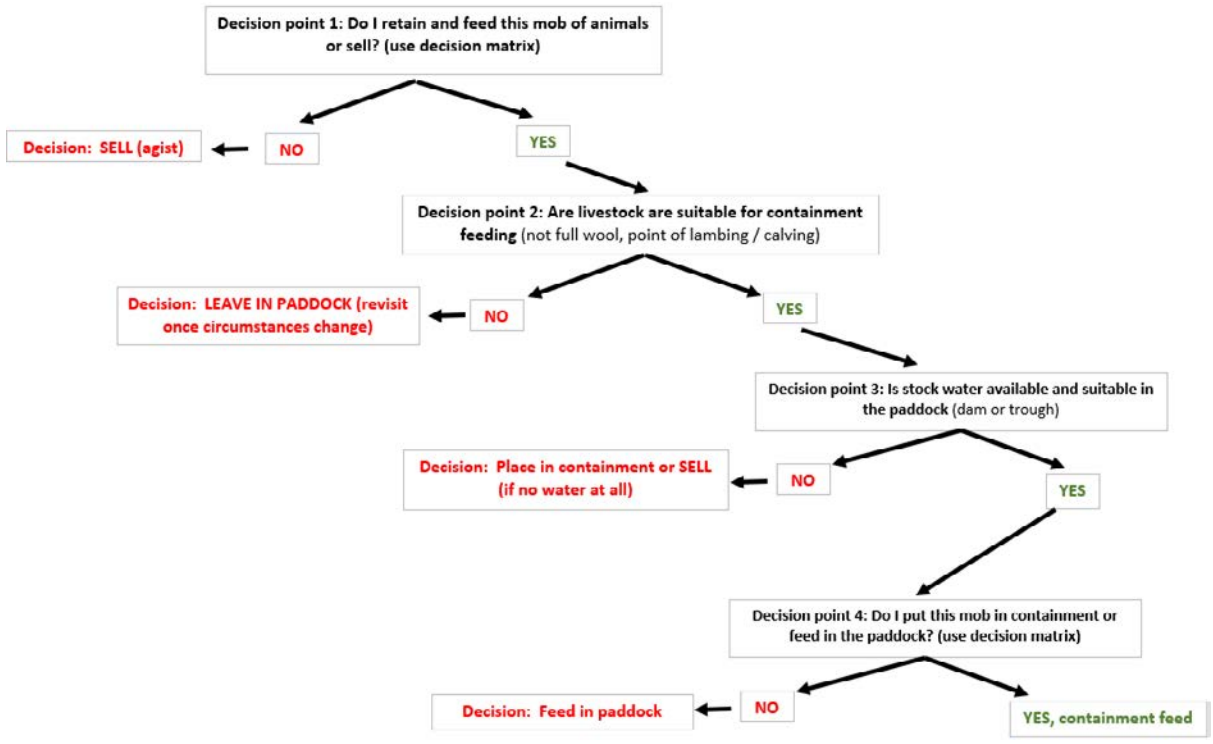
The decision matrix contains five important pieces of information.

These are:

- A clear statement of the **decision being made.**
- A list of the **critical factors** or headline phrases that should be considered.
- Further descriptions around each critical factor, where you think differently about what you should do. These are referred to as **tipping points** and can be objective (numbers, values) or subjective (descriptions).
- The importance of each of the critical values and tipping points compared to each other. This recognise that different critical factors may not be of equal importance. These are referred to as **relative values**.
- The **decision statements** and **scores**. This incorporates the individual appetite for risk.

As an initial step, the flow chart in Figure 1 is recommended to work through with your advisor when considering containment feeding.

FIGURE 1: Flowchart to decide if animals should be placed in containment (larger version in Appendix 2).



There are two simple and two complex decisions for a farmer to work through before containment feeding livestock.

The complex decisions are:

Decision point 1: Do I retain and feed this mob of animals or sell? (Table 1, below).

Decision point 4: Do I put this mob into containment or feed in paddock? (Table 2, next page).

TABLE 1: Do I retain and feed this mob of animals or sell them?
Source: Knewleave Partnership, Geelong, 2022.

Decision point 1: Do I retain this mob of animals and feed or sell them?				
Critical factor	**Consideration (tipping point)**	**Value**		**Score**
Current V future livestock price	Low now, likely to be more in the future	6		
	Will retain similar price over time	4		
	High now, likely to be less in the future	0		
Type of animal	High merit breeding stock, younger, essential to rebuilding	6		
	Lower merit breeding stock, older, useful for rebuilding	5		
	Non breeders, but additional value if grown out	3		
	Non breeders, easily replaced	0		
Anticipated length of feeding required	Short term (3 months or less)	5		
	Moderate period (3 to 6 months)	2		
	Extended period (greater than 6 months)	0		
Supp feed available	Lots available on farm or can replenish easily at good price	4		
	Some on hand, but would probably need more, price high but fair	3		
	Little on hand, would need to buy in, hard to get, expensive	0		
Infrastructure and time to successfully feed	Have enough infrastructure and labour to feed all stock if necessary	4		
	Some limitations but could make it work reluctantly	3		
	Limited infrastructure, equipment and time	0		
Emotional attachment	High, would hate to sell them	2		
	Some, but could do if had to	1		
	None	0		
		27		**0**

Decision	Score
Retain and feed	19 or above
Sell	Below 19

TABLE 2: Do I put this mob into containment or feed in paddock?
(Source: Generic examples from trigger point workshops using objective descriptions)

Decision point 4: Do I put this mob into containment or feed in paddock?		
Critical factor	**Consideration (tipping point)**	**Value**
Feed available in the paddock	Less than 1000kg/ha, plant crowns being grazed	9
	Between 1000 kg/ha and 2000 kg/ha	6
	Greater than 2000 kg/ha, stock camping	0
Groundcover (soil protection)	Less than 70% on flats, 90% on slopes, hooves loosening the soil	5
	Between 70%-80% on flat ground, 90%-100% on sloping ground	3
	Greater than 80% on flat ground, 100% on sloping ground, soil stable	0
Quality of pasture	White (washed out), less than 50% DDM, 6.5 MJME/kg	4
	Brown, between 50%-70% DDM, 6.5 - 10.0 MJME/kg	3
	Green, greater than 70% DDM, 10 MJME/kg	0
Containment facility (infrastructure)	Ready to go, set up, suitable for current needs	4
	Needs some effort to be made suitable	2
	No infrastructure available, have to construct	0
Labour efficiency in feeding	Yes, reduce time feeding, less labour required	3
	No gain, paddock feeding is easy, labour is available	0
Seasonal forecast	No rain forecast or rain would cause problems	2
	Some rain, but only minor pasture growth will result	1
	Significant rain imminent that would lead to useful pasture growth	0
		27

Decision	Score
Yes, place in containment	19 or above
No, leave in paddock and feed	Below 19

Other common critical factors that could be considered in the decision matrix are listed to the right. These can provide a useful prompt when developing the critical factors list, noting that the important critical factors will differ between enterprises and regions.

Other possible critical factors to consider:

- Economic consideration (long term feeding costs V restocking)
- Implications on cashflow
- Confidence to feed successfully
- Commitment to feed for as long as it takes
- Stress levels

The six most common critical factors included in Table 2, and their relative importance were derived from the twelve trigger point workshops held across South Australia, Victoria and Tasmania.

A complete list of the critical factors identified from all workshops is provided in Table 3, below.

This list can provide a useful prompt when developing the critical factors list for each farmer and regional groups.

TABLE 3: Critical factors identified by farmers in the 12 trigger point workshops.

Critical factors identified	Times listed (out of 12)
Feed available in the paddock	12
Groundcover (natural resources)	10
Containment facility (infrastructure)	9
Quality of feed	5
Labour efficiency in feeding	9
Class of livestock	5
Seasonal forecast	6
Livestock condition	3
Animal health	2
Animal welfare	2
Pasture establishment, build feed wedge	2
Future use of the paddock / availability of paddock	2
Soil type (in paddock being grazed)	1
Stock skills (husbandry)	2
Improvement in animal feed efficiency	2
Public perception	1
Alternative paddock feed (failed crop)	1
Feed on hand	1
Paddocks suitable to hold stock for long periods	1
Lifestyle	1

The two simple decisions are:

Decision point 2: Are livestock suitable for containment feeding? Animals would probably be excluded if they were in full wool (dust, rubbing) or within 4 weeks of the point of lambing / calving (for privacy, mothering reasons).

Decision point 3: Is stock water available and suitable in the paddock? Carting water is general considered unrealistic because of the quantities required. A suitable dam water source would:

- Salinity (Electrical conductivity or EC)[1] (see water in containment section for threshold levels).
- Be firm around the dam edge so stock don't get bogged when drinking.

Further resources around decision making

https://grdc.com.au/resources-and-publications/all-publications/publications/2020/farm-decision-making

https://www.youtube.com/watch?v=nsMa2VtnONU

https://decisionwizard.sfs.org.au/

[1] Low cost pen type EC meters are handy e.g. https://www.scienceequip.com.au/products/pen-type-ec-tds-meter-aquasol

PEN SETUP

Fencing type

Containment pens can be erected for sheep relatively cheaply and easily. Standard hinge joint or ring lock fencing is suitable, avoid narrower wire or smaller squares at fence posts or droppers as sheep may get their head stuck (Figure 2 and 3)..

- Steel posts can be generally spaced between 3 to 5m
- Wooden posts (treated) can be spaced between 3 to 5m
- Plain wires are an option at the top, middle and bottom of the fence. Barbed top wires are unnecessary.
- If troughs are constructed in the fence lines a few cable wires with tensioners work well to prevent stock from getting into the trough.

FIGURE 2: Steel Droppers and ring mesh fencing works well.

FIGURE 3: Steel posts and ringlock fencing with plain wires where stock need to access the trough in the fenceline.

Laneways/Gateways / Roadways

A laneway assists with stock movements to and from the containment area. If it's located close to sheep yards and/or shearing sheds a laneway through to these frequently used areas' is ideal. The width of the laneway should consider feed out machinery (or future machinery) that will need to access pens.

Gateways should be wide enough to allow machinery to access the pens if required and also to allow successfully stock movements in and out of pens. In some cases, a double gate (an extra gate hung on the opposite side of the laneway) allows the whole lane to be closed off and ewes to be easily moved in and out of pens.

Roadways will need to be all weather. Although we often think of containment feeding in 'dry times' often stock are in the pens over the break of the season. Any access roads or access to feed out areas will need to be compacted gravel and large enough to allow any future machinery to access the area. When feeding all weather turn around circles also need to be considered.

Site selection

When considering site selection many things need to be considered. The first is locality to existing sheep handling facilities such as permanent yards and the shearing shed. Containment lots ideally should be set up within easy access to these areas – either located close by or have good laneway access to move stock back to these facilities. When they are easily accessible many people find they use their containment lots at other times of the year for holding stock prior to shearing, quarantine pens or holding rams etc. Ideally feed storage will also be located close to the containment pens so you're not carting feed long distances (Figure 4).

FIGURE 4: Locating the containment yard next to other handling facilities and shearing sheds allows it to be used at many other times of the year.

Shade & shelter

Shade and shelter are important to avoid heat and cold stress. Especially when joining in containment and through pregnancy heat stress can have an impact on the joining results and foetal size, etc through pregnancy.

Sheep are quite tolerant of climatic extremes. Their thermoneutral zone (temperature range they don't have to expend energy to maintain normal body temperature) ranges between 12 to 32 degrees Celsius (LLS, 2023). Utilising shade and shelter to assist them to stay within this zone will reduce energy expenditure and improve production results.

Recommendations are to have a minimum of 0.4m^2 of shade per ewe /lamb in a containment pen. Shade is ideally located away from feed and water to minimise congregation around these areas.

FIGURE 5: Netpro permanent shade set up across multiple pens.

Shade should be orientated in a North-south direction to maximise shade throughout the day and also allow the shade to move across the pen through the day to allow the ground to dry out after a rain event.

Shade can be constructed from many materials such as galvanised or corrugated iron or heavy-duty shade cloth (minimum 300 grams per square metre). They can be semi-permanent or substantial permanent structures (see Figures 5 to 9 for examples).

Shade should be high enough to maintain airflow across the pen and allow the ground to dry out if required.

Shelter can help prevent cold stress by reducing wind chill across a pen. The protected zone from a windbreak may extend out 25 – 30 times the height of the windbreak with a marked drop in wind speed (Local Land Services, 2023). Shelter can be provided by stacking additional structures around a pen, such as straw bales, using solid fencing such as galvanised iron or K-rail, or planting native vegetation around more permanent pens. It is best if the wind break is 90° to the prevailing wind direction.

FIGURE 6: A semi-permanent effective shade set up.

FIGURE 7: Effective shade doesn't have to be expensive.

FIGURE 8: Planting of native vegetation i.e. old man saltbush can provide effective shelter.

FIGURE 9: Solid fencing material can assist to reduce wind speed across a pen.

FIGURE 10: Slope across a pen allows water to drain.

Slope

Slope is critical in a containment pen to allow good drainage, avoid water ponding areas and help prevent pens becoming boggy when it's wet (Figure 10). Ideally slope will be 2 to 4 per cent from the top to bottom of the pen. Water troughs are ideally located at the bottom of the slope so run off is out of the pen. Slopes that are too steep are prone to erosion and also require more energy for stock to move around them therefore increasing feed requirements. Sites that become boggy will predispose stock to feet problems such as foot abscess and scald and also can harbour soil borne diseases such as coccidiosis or salmonellosis. If water needs diverting levy banks and channels can be created if required.

Pen density

When looking at recommendations of stocking densities within sheep containment systems, there is a vast range of recommended m^2 per ewe. There has been a lack of definitive research in terms of stocking density impact(s) on social welfare, stress and livestock performance within sheep confinement systems (Local Land Service, 2023).

Increasing stocking density (reducing the area per head), may help to reduce dust within the confinement area by increasing the urine and manure deposited on the pen surface. It will also reduce infrastructure cost. However high stocking densities can result in an increase in animal health related problems.

As a general guide $5m^2$ is recommended per ewe as a minimum. If ewes are going to be held in containment during late gestation $10m^2$ per ewe is ideal.

There are some recommendations for pen size for lambing, however containment pens aren't generally suitable for lambing due to an increase in animal health issues. Small paddocks are much better spaces for lambing in dry times, especially scrub areas or spaces with significant shelter and privacy.

Mob sizes and number of mobs

The mob size is dependent on the number of breeding stock being run on the property. As the mob size gets larger and dependent on the feeding method, you can start to get higher numbers of shy feeders or lower condition score stock within the mob.

Smaller mobs are often easier to manage, feed and monitor. Ideally mobs of 250 to 300 ewes work very well. In larger breeding flocks' older ewes can be successfully run in mobs of around 500 ewes provided enough trough or feeder space is provided.

It can be useful to have a few spare pens to allow extra mobs to be created if required. If ewes are containment fed for a long period of time, any lower condition score ewes can be separated from the mob and fed in a separate pen to enable all ewes to successfully hit condition score targets.

Managing dust / new pens

Dust can be an issue in containment pens, especially in newly built pens. The best way to combat this long term is to get the stocking density in the pen right. At the correct density manure and urine will assist to form a mat in a new pen, some straw etc spread across the pen can also assist in the first year. Dust is also very dependent on soil type. Short term strategies like wetting down pens or oil can assist to suppress dust.

Excessive dust can lead to coughing of stock which can lead to prolapse in severe cases, it also can aggravate eye conditions such as pink eye.

After the first year of utilising pens, dust is likely to be less of an issue going forward.

STATE REGULATIONS AND CONTAINMENT APPROVAL

The ruling on approval of containment areas varies from state to state.

Buffer distances also vary from state to state and are generally shown in the planning regulations.

EPA (SA) states the fixed separation distances for intensive animal keeping is in the table to the right (Table 4).

South Australia

South Australian legislation around containment feeding is according to the Planning and Design Code available with Plan SA.

Further information is available: Planning and Design Code - Version 2023.15 - 26 October 2023

New South Wales

In New South Wales legislation, specifically the State Environmental Planning Policy (Primary Production and Rural Development) 2019, confinement areas are referred to as stock containment areas and they generally do not require development consent.

Further information is available: State Environmental Planning Policy (Primary Production and Rural Development) 2019 (nsw.gov.au)

TABLE 4: Acceptable distance from roads and waterways (www.epa.sa.gov.au).

Public road - except as below	200 m
Public road - unsealed with less than 50 vehicles per day excluding feedlot traffic	50 m
Major watercourse	200 m
Other watercourse as defined by a blue line on a 1:50000 current SA Government topographical map	100 m
Property boundary	20 m

Victoria

In Victoria, Stock containment areas used for emergency, seasonal or supplementary feeding are considered as being part of grazing animal production under the Victorian planning scheme. A permit is not required to build or operate a SCA used for emergency, seasonal or supplementary feeding of livestock in most rural zones.

Further information is available:
https://www.vgls.vic.gov.au/client/en_AU/vgls/search/detailnonmodal/ent:$002f$002fSD_ILS$002f0$002fSD_ILS:625205/one

Tasmania

Containment feeding regulation and approval within Tasmania sits with individual councils.

CONTAINMENT FEEDING OPTIONS

There are many methods in which you can successfully feed ewes in containment pens. It is normally a trade-off between the cost of set up and labour required to feed stock into the future. The more expensive elaborate set-ups often allow large numbers of ewes to be fed quickly and accurately whereas a cheaper set up can work very well but often requires more labour.

Some type of feed bunk or troughing is required in many of the pen set ups to avoid feeding on the ground. Trail feeding on the ground in pens isn't recommended due to feed wastage and animal health issues.

Self-feeders can be an option and can reduce labour as they can often be filled less frequently, however it's important to monitor them very closely to ensure that stock don't overconsume. Some self-feeders are more suitable for ad-lib feeding, when using self-feeders in containment it's better to use a 'lick type' self-feeder. Lick self-feeders will often have two adjustable sliding sections and also a lick plate to allow a more precise adjustment of the consumption from the feeder.

Feed troughing can be constructed from many different materials at many different price points. The advantages and disadvantages of a range of materials is shown in Table 5.

Sacrifice paddocks are an option initially prior to constructing pens. They can be a way to maintain ground cover and feed on offer on other parts of the property and utilise a few smaller paddocks to hold ewes. Similar feeding set ups can be utilised in a sacrifice paddock and then move to a pen if the setup evolves down the track. Even utilising electric fences to hold stock in a smaller area is a benefit rather than deteriorating a whole paddock.

TABLE 5: Advantages and disadvantages for a range of materials used for feed troughing.
Source: A guide to confinement feeding sheep and cattle in NSW, 2023

Material	Advantages	Disadvantages	Indicative cost
Shade cloth (polyethylene or polypropylene)	Lightweight, easily assembled Ration dust and fines fall through Water won't pool in trough base	Limited life expectancy	<$3
Tractor tyres	Durable Readily available Low cost Good linear trough space per tyre	Height of sides for smaller stock Care steel belting does not get exposed and/or ingested by animals Sheep tend to jump into tyre and soil the feed	-
Poly belt/tarp (polyethylene)	Light (2 kg per m²) and sturdy Wide range of widths and thicknesses Environmentally stable and flexible Easily fixed to timber/steel frames	Heat may be an issue in summer months	<$9
Plastic/PVC (polyvinyl chloride)	Reasonably light and sturdy Wide range of widths and thicknesses Environmentally stable and flexible	Can become brittle with time	<$9
Conveyor belt (nylon ply, solid woven or steel cord threaded rubber options)	Sturdy, environmentally stable Can be split width wise and lengthways Longevity	Can be difficult to split Reasonably difficult to work with	<$12
Galvanised steel (Corrugate, Trim deck, 'C' section, 'W' strap etc)	Sturdy Longevity	Heat may be an issue in summer months Reasonably difficult to work with	<$15
Concrete	Sturdy Longevity	Expensive Heavy to move, handle	>$50

Communal Trough

A communal trough works well in a feeding lane, as one set of troughing can be used to feed multiple groups of ewes which reduces infrastructure cost. The other option is to have a separate spare feeding pen and move stock across a pen when a grain feed is required.

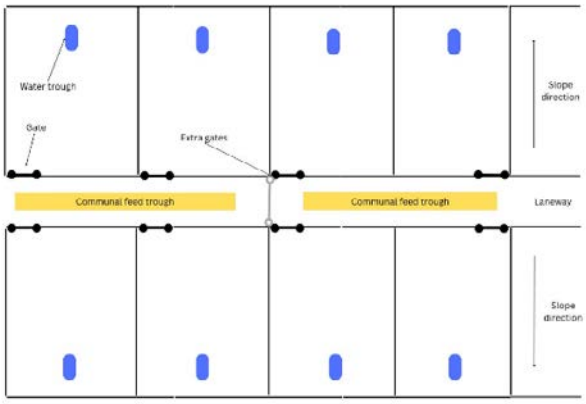


FIGURE 11: Communal trough example.

Feed trough in pen

Having a feed trough inside the containment pen means less trough space is required as ewes can access double sides. However, the disadvantage is trying to drive into the pen with ewes in there. This can work for slug feeding or a TMR depending on the trough design.

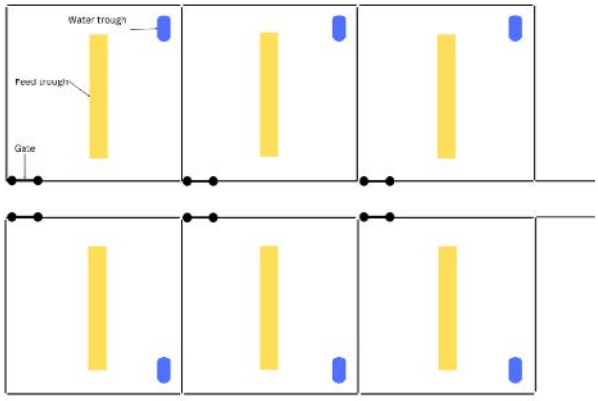


FIGURE 12: Feed trough in pen example.

Feed trough in fence line

Having a feed trough in the fence line makes it very easy and quick to feed ewes without moving them out of the pen. You'll need to ensure that there is a very long fence line available with feeding access if 'slug feeding (feeding all ewes at once)'. If you can mix a total mixed ration (TMR) and have it continuously available, you can make do with less trough space as feed is available ad-lib. You will however also need larger troughs to enable more feed to be contained at a time.

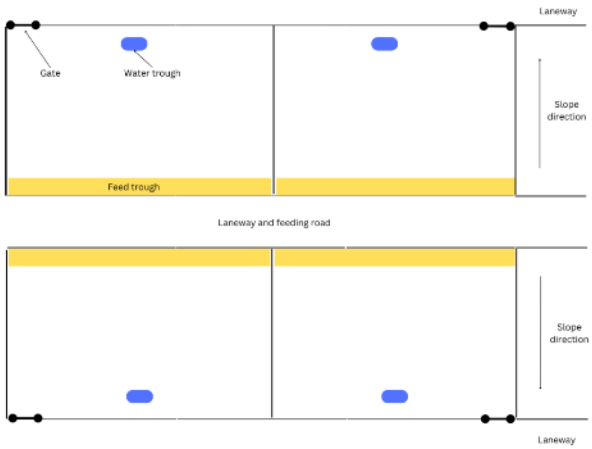


FIGURE 13: Feed trough in fence line example.

Self-feeders in pen

Self-feeders can be used to reduce labour requirements and allows less feeding space per ewe as feed is always available. Stock can easily over-consume and become too fat so it's important to use a lick feeder type and monitor very closely.

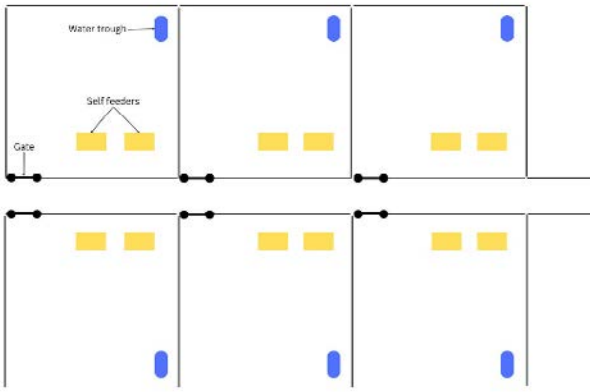


FIGURE 14: Self feeders in pen example.

FIGURE 15: A feed trough in a fence line large enough to hold a TMR mix, stay tight cable allows stock to put their head through into the trough.

FIGURE 16: A trough in a fence line able to be accessed by a pen each side.

FIGURE 18: A communal trough works well to reduce infrastructure and allow all ewes plenty of trough space.

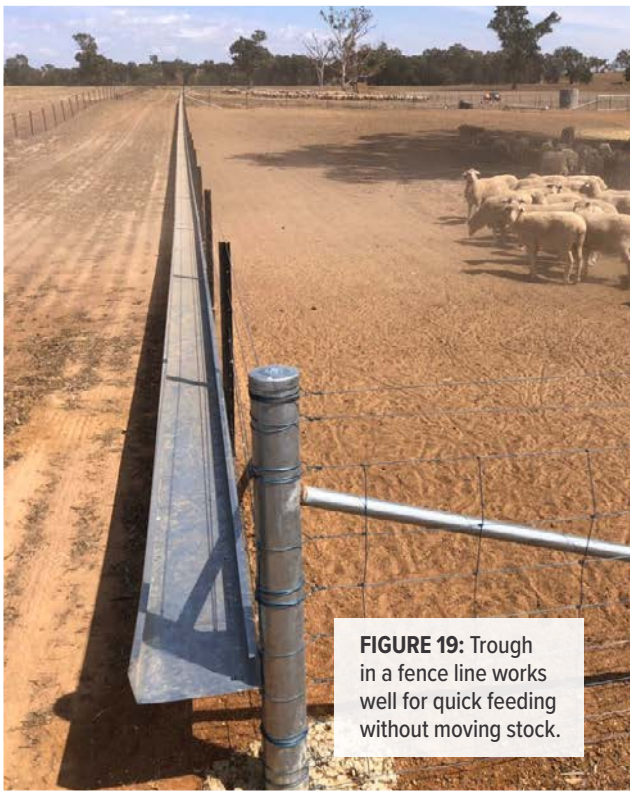


FIGURE 19: Trough in a fence line works well for quick feeding without moving stock.

FIGURE 17: Feed trough in a containment pen to hold a TMR mix.

High quality-based fodder feeding

If you have access to high quality fodder (i.e. silage) and dependent on the stage of pregnancy, ewes can be contained and fed straw, hay and silage and still reach their energy requirements. This reduces the reliance on feeding infrastructure and ewes can be fed less frequently with fodder available ad-lib. You will need access to different quality fibre to ensure ewes aren't over or underfed.

FIGURE 20: A cheap but effective method of reducing hay wastage.

Feed out equipment

Equipment required is dependent on the feeding system that is set up as above. A TMR will require a high-quality feed mixer capable of chopping roughage and mixing it through the ration. As ewes get later into gestation the ration will change substantially from a high proportion of roughage through to a more energy dense ration.

When filling feeders and feeding in troughs a feed out cart that can feed over the fence will save a lot of time driving in and out of pens and reduce the risk of running over stock. Ideally being able to feed into a trough or self-feeder slightly away from the fence will allow double sided access and mean less troughing or feeders is required.

Automatic feeders are a labour-saving option however due to trough space required per ewe they can be a very expensive way of setting up to feed. As they deliver feed often in 4 – 5 feeds across a day, ewes all need to be able to line up at the same time.

FIGURE 21: Hay feeders reduce wastage substantially.
(Source: www.advantagefeeders.com.au).

FIGURE 22: Shepherd autofeeder supplying stock feed across the day.
(Source: Shepherd Ag: www.autofeeder.com.au).

TABLE 6: Trough space required and a summary of positives and negatives associated with each feeding method.

Feeding Methodology	Trough space required / ewe	Positives	Negatives
Communal trough – 'slug feeding'	30 – 40cm (Single sided) Space required dependent on ewe size / wool amount.	• Less infrastructure cost as multiple mobs can share trough. • Ease of feeding while ewes are in separate pen. • Controlled quantity of grain / pellet. • Can feed roughage in pen while ewes are eating. • Double sided access reduces trough space required, reduces cost. • Eliminate risk of stock deaths from being run over by vehicles.	• Considerable labour requirement to let ewes in and out. • Increased feed out time as pens are fed individually and staggered depending on eating time. • Requires someone to feed daily or every second day.
Trough in pen fence line – 'Slug feeding'	30 – 40cm (Single sided) Space required dependent on ewe size/wool amount.	• Short feeding time as all pens can be fed in one hit. • Controlled quantity of grain / pellet. • Eliminate risk of stock deaths from being run over by vehicles.	• Large fence line required for ewes to all line up single sided unless feeding equipment allows trough to be back from fence line (double-sided access). • Decent feed out infrastructure required to feed over or through a fence line.
Trough in middle of the containment pen.	15 – 20cm (double sided) Space required dependent on ewe size/wool amount.	• All ewes can be fed in one hit. • Controlled quantity of grain/pellet. • Can use a simple trail feeder as can drive over a low trough.	• Time consuming driving into each pen and risk of stock deaths from being run over.
TMR available ad-lib in trough.	14cm (single sided)	• Consistent feeding with precise nutrition due to all being chopped into TMR. • Labour required to feed 3 x a week and ensure ration spot on so ad-lib available all the time. • Less trough space required as feed is available ad-lib.	• Troughs with a decent capacity need to be constructed. • Mixer (expensive infrastructure) required to do a TMR.
Self-feeders	3 – 5cm/head (100 – 120 head per 2.4 metre feeder)	• Ease of filling up feeders, lower labour as less frequent. • Feeders can be multi-purpose i.e., used in paddock too.	• Expensive set up cost for a number of feeders. • Ewes can over or under consuming and end up with inconsistent condition score. • Need decent feeding infrastructure if filling up from outside of the pen – otherwise risk of running over stock.
High quality fodder in pens	Ad-lib hay / silage in pens	• Ease of feeding with limited infrastructure. • Can feed over the fence with a decent tractor.	• Hay feeders are preferable to avoid wastage. • Varied fodder quality means some grain or pellet will have to be included in the ration at times.

WATER IN CONTAINMENT

Suitability of water

TABLE 7: Suitability of water.

Category	Class of stock	TDS (ppm)	Mg (ppm)
1	Suitable for sheep and cattle of all ages.	<5000	<600
2	Generally unsuitable for lambs, calves and weaners. Caution with lactating stock.	5000–10,000	<600
3	Suitable for dry mature sheep. Caution with cattle if unaccustomed.	10,000–15,000	<600
4	Unsuitable for all stock.	>15,000	
5	Unsuitable for all stock.		>600

The most important water quality limiters are Salts and Magnesium level – suitability of water is shown in Table 7. It's critical to have water with low salt levels when sheep are locked in containment to prevent decreased feed intake and animal health issues. There are other important factors to look at such as pH. Ideally water for stock use should be in the range 6.5 – 8.5, if the pH is highly acidic (less than 5.5) acidosis and reduced feed intake can occur. Highly alkaline water (over 9) can cause digestive upsets and diarrhoea (DPI NSW, 2014).

Water quality can also be diminished if levels of other nutrients and contaminants are high. High levels of minerals in water supply can also have a negative correlation with other minerals required for production i.e. high fluoride levels in some bore water will interfere with phosphorus absorption in the animal.

High levels of microbes and algal blooms can also be an issue in stationary surface water sources with a high concentration of organic material e.g. manure, during sunny weather (temperature 15–30°C) and in water with a pH of 6 or greater.

There are many laboratories that can test water quality quickly and easily and assess its suitability for livestock.

Water setup and trough options

Troughs are recommended for water supply, avoid creeks or dams to water ewes in confinement as they will become boggy and water quality can be compromised. Water trough space recommendations in the past have been:

Sheep: 30cm + 1.5cm per sheep

Example: 250 sheep = 30cm + (250 x 1.5cm)

However, now it's thought flow rate is more important. It is important that water is always available on demand. Ensure that pipe size (diameter) and water pressure can deliver water when it's needed. If water is high pressure and troughs are replenished quickly total lineal access isn't as critical.

Low volume troughs are useful as they will need to be cleaned out regularly. Frequency will depend on temperature, algal growth, winds, and dust contamination. In summer daily cleaning is recommended. Lower volume means less water is being wasted on the ground.

Water troughs should be located on the low side of the pen with drainage preferably running out of the pen to avoid bogging in areas of the pen, especially as troughs are emptied. A concrete apron (or other alternative material) around the water trough is ideal to prevent holes from developing and the ground bogging up. Ideally water troughs should be located the opposite side of the pen from feed troughs to prevent feed contamination.

FIGURE 23: Low volume sweep out troughs are easy to clean and reduce water wastage. *(Source: Deb Scammell).*

FIGURE 24: Croc trough pump set up to reticulate water around the trough and reduce dust film. *(Source: croctroughpumps.com.au).*

Cleaning of troughs and other hardware

Troughs need to be cleaned regularly to ensure stock are drinking adequate water. Dust or a film can restrict water intake. There are also some pump set ups available which reticulate water around the trough which can reduce the need to clean as frequently. Automatic cleaning troughs are also an option to reduce labour.

FIGURE 25: Sweep out troughs with appropriate broom makes it very easy to clean out and low volume means less water is being wasted.

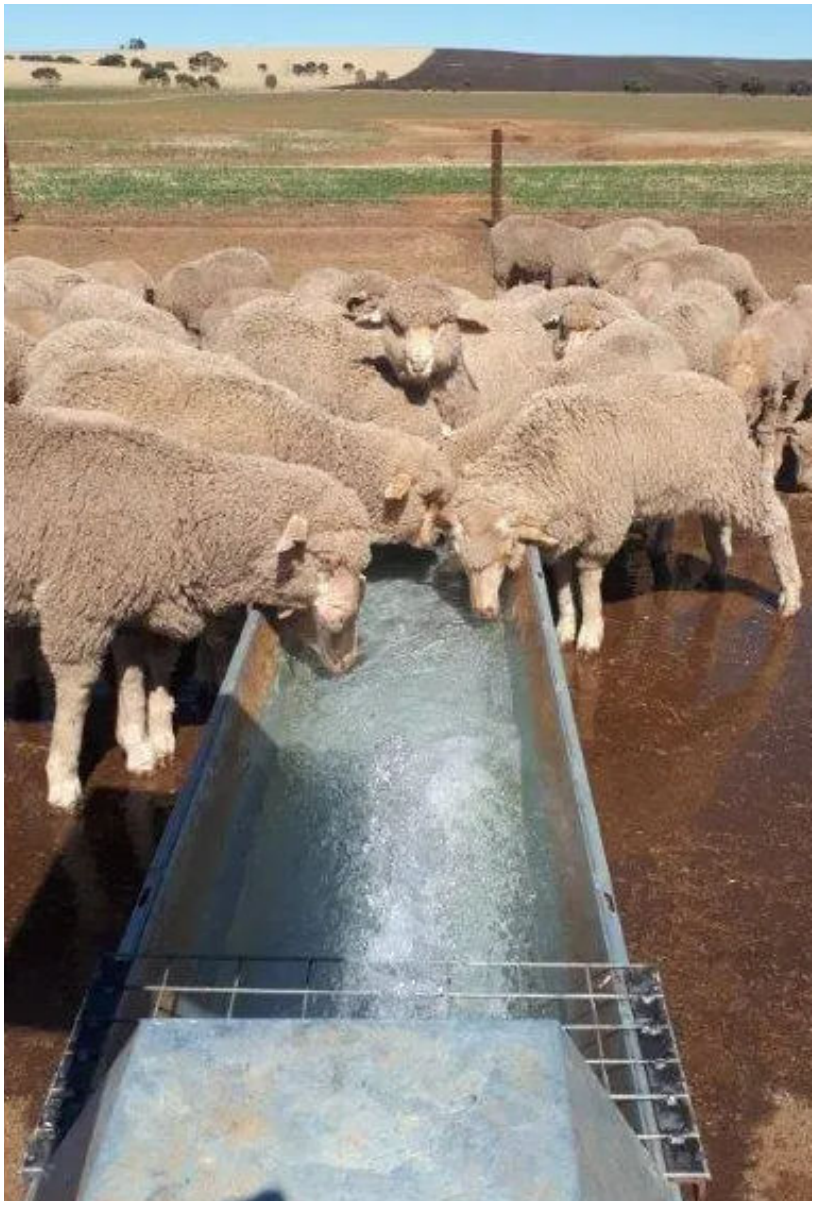


FIGURE 26: Shepherd automatic flushing water troughs. *(Source: www.autofeeder.com.au).*

Water requirements

When determining water intake and water that needs to be held on site, it is important to consider the extremes. Water intake will increase with increasing temperature, e.g. water consumption by sheep can increase by 80 per cent in extreme, hot conditions. Sheep can drink 40 per cent more water in summer than winter and 50 – 80 per cent less if water contains more than 2000 parts per million (ppm) total dissolved salts (Making more from Sheep 2015).

TABLE 8: Daily water intake estimates.
(Source: DPI NSW 2014)

Stock Type	Consumption per head per day (L)
Sheep – Weaners	*2 - 4*
Adult dry sheep *Pasture* *Saltbush*	 *2 - 6* *4 - 12*
Ewes with Lambs	*4 - 10*

The stage of production (e.g. pregnant or lactating) also significantly affects water requirement. Ewes raising twin lambs require 50 per cent more water ewes with a single lamb.

Sheep water consumption example

5000 ewes (late pregnancy in summer)
@ 8 Litres / ewe/day

5000 x 8 = 40,000 Litres

3 days' supply = 120,000 Litres
(minimum header tank volume required)

It is important to have a backup water supply (i.e. header tank) of 2 to 3 days' supply so if there is a water issue i.e. pump breakdown or water leaks, you're holding enough water to continue watering animals while it's fixed.

FIGURE 27: Header tank example.

NUTRITION IN CONTAINMENT

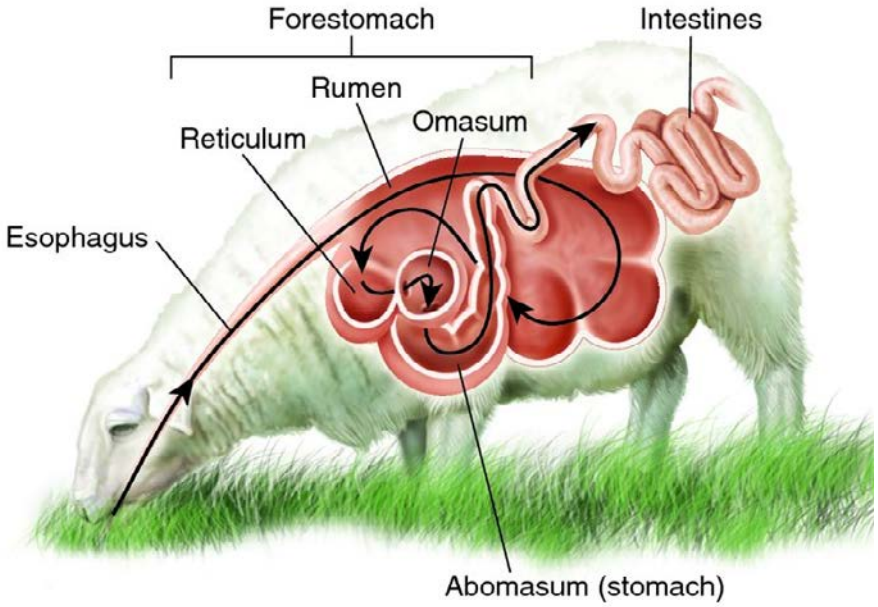


FIGURE 28: Components of the ruminant digestive system.

Ruminant anatomy

Sheep are ruminants which means they have a specialised stomach equipped to turn fibrous material into high quality nutrients for production. The Ruminant is a single stomached animal with four compartments. Components of the digestive system are described above.

Mouth

The breakdown of feed begins in the mouth. Sheep consume the feed and briefly chew it to 1-5cm lengths while adding large amounts of saliva, then swallow it via the oesophagus into the rumen. If the animal has satisfied its hunger it will ruminate (chew its cud), further decreasing the size of the pieces to increase the surface area of the food for microbial digestion.

Oesophagus

Food is transferred to the stomach via the oesophagus where muscular contractions propel chewed feed towards the rumen. The oesophagus also moves digesta (the cud or bolus) from the rumen to the mouth where it is further ground by chewing to make it easier to digest. Chewing stimulates saliva production and ensures adequate bicarbonate is produced. This buffers the large quantity of acid produced in the rumen and is critical for maintenance of rumen pH.

Rumen

The rumen acts as a fermentation vat in which plant material is broken down by millions of microorganisms. Between 60 and 70 percent of all digestion happens in the rumen. In the rumen the fermentation of fibre results in the production of acetic acid that is used by ruminants for energy. Carbohydrates are fermented to volatile fatty acids, which are then absorbed across the rumen wall where they enter the bloodstream and are converted in the body to glucose and fat. Protein consumed in the diet is converted to microbial protein.

Rumen microorganisms

The rumen is home to a vast number of microorganisms (bacteria, protozoa and fungi). Different populations of bacteria will dominate the rumen fermentation depending on the type of diet being fed. Diets high in fibre will result in a rumen bacterial population that is high in fibrolytic bacteria. Amylolytic bacteria are more prolific when diets high in starch are fed.

Rumen bacteria undertake all the necessary processes to break down and digest plant material to produce microbial protein (ruminants' main source of protein) and volatile fatty acids (ruminants' main source of energy). The diversity of rumen

bacteria allows them to break down all the different components of plants.

The type of feed livestock eat influences the rumen environment. For example, mature dry grasses are low in protein and simple (easily digestible) carbohydrates, thereby limiting microbial growth. Conversely, high-grain diets can lead to high acidity (low pH) that is toxic to many rumen microorganisms, inhibiting microbial growth and digestion.

The rumen microbes require a certain amount of nitrogen to operate efficiently. In times of a deficiency of true protein, non-protein nitrogen sources such as urea can be used to ensure the rumen operates to its maximum level of efficiency in animals with a functional rumen. However, these sources can only be used to supplement small quantities of protein; when there are severe protein deficiencies this will not provide enough.

Reticulum

Food not digested in the rumen, as well as rumen microbes, pass through the omasal orifice located in the reticulum, then into the omasum. The reticulum's lining has a honeycomb appearance which collects the smaller digesta particles to move them to the omasum, the larger particles remain in the rumen for further digestion.

Omasum

The omasum acts as a filter, sorting out liquid and particles. It reduces the amount of water passing out of the rumen and allows finer particles to pass through to the abomasum while retaining coarse particles.

Abomasum

The abomasum is the true, gastric stomach of the animal, similar in function to the stomach of monogastric animals. Protein and some fats are digested in the abomasum with the aid of hydrochloric acid and enzymes.

Small intestine

The small intestine is the main site for the digestion and absorption of amino acids, fats and the limited amount of glucose that may be available. The bile and pancreatic ducts open into the small intestine, delivering enzymes, solvents, buffers and other agents (such as sodium bicarbonate) to aid digestion.

Passage through the rumen

The passing of material through the rumen affects the extent of digestion. The general rate of passage depends on density, particle size and ease of digestion. Some foods pass through the digestive system fairly quickly while others, of lower digestibility, may be excreted over a longer period. Provided, adequate fibre is in the diet a dense floating mat should form in the rumen, this will slow the rate of digestion and is useful when high starch rations are being fed as it maintains a good rumen microbe balance. If very high fibre diets are being fed, the ruminating time can be quite slow – reduced the passage through the rumen which can mean less feed is consumed.

Standard reference weight

Standard reference weight is the liveweight of a fully grown, bare-shorn, non-pregnant sheep in condition score three (CS3) with no gut fill (i.e. empty) (AWI, Standard reference weight calculator). Determining the standard reference weight (SRW) of your ewe flock provides a useful comparison of animals of varying weights and condition scores to determine their energy requirements for maintenance or growth. When containment rations are formulated the energy requirements of a ewe are determined by the SRW of the ewe flock. For assistance with calculating a SRW: standard-reference-srw-calculator-3.pdf (wool.com)

Condition scoring

Condition scoring is the best way to ensure your ewes are on target through pregnancy and the containment feeding period. Condition scoring is an easy and accurate method of estimating the condition or 'nutritional well-being' of your ewe flock. It requires an assessment of the amount of muscle and fat covering the backbone and the short ribs of each animal and is different to the old method of fat scoring. This gives a picture of the animal's store of energy and is the best method for assessing pregnant, lactating and dry stock.

It can be useful to group ewes in containment pens based on condition score rather than age to ensure you successfully hit condition score targets through the feeding period (See Figure 28).

Condition score targets

Recommendation for merino ewes include lambing single bearing ewes at Condition Score (CS) 3 and twin bearing ewes at CS 3.3 (Lifetime wool, 2006).

Targets for maternal ewes differ slightly the optimum targets are to join maternal ewes at CS 3.8 – 4.1, they can then lose condition during pregnancy (up to 1 CS), to ideally lamb at CS 3 – 3.1 for single bearing ewes and CS 3.4 – 3.7 for multiple bearing ewes. Modelling has been done as dependent on meat and grain price optimum targets can change slightly (Blumer et al, 2019).

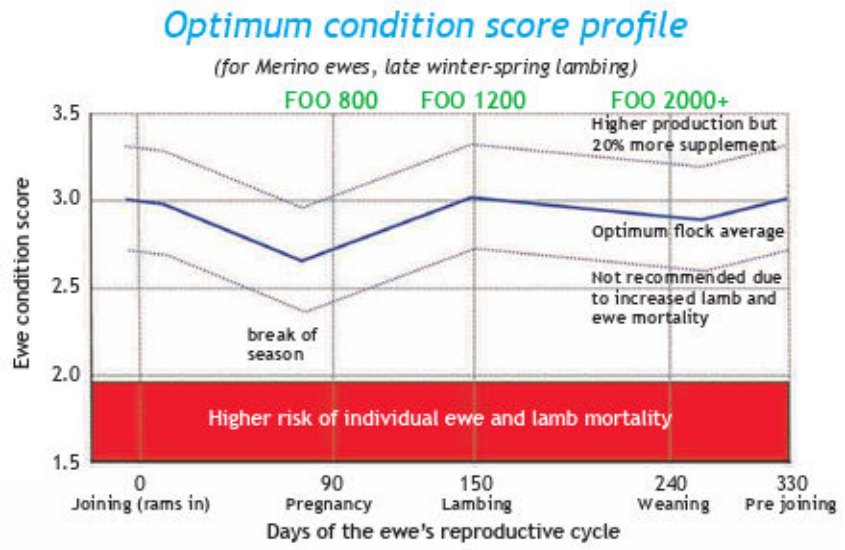


FIGURE 29: Optimum condition score targets. *(Source: lifetimewool.com.au).*

Condition Score 1	No fat and very little muscle on the backbone and ribs. Seriously low body condition. Quite unacceptable — prone to disease and at risk of death.
Condition Score 2	A small amount of muscle along the backbone but no fat. The least acceptable condition for thrift. Perhaps acceptable for dry sheep when the feed is short but a clear indication that nutrition requires attention.
Condition Score 3	Good level of fat and muscle with rounded ends of ribs and top of backbone. A good level for Merino ewes from joining to lambing and an ideal condition for young sheep.
Condition Score 4	Over-round across backbone — lots of muscle and fat. Tending towards over-fat.
Condition Score 5	Can't feel the backbone or ribs. Definitely over-fat. Too fat for slaughter.

FIGURE 28: Condition Scoring of Sheep. *(Source: lifetimewool.com.au).*

Energy

The energy content of feed or energy required by an animal is measured as metabolisable energy (ME) per kg of dry matter, expressed as MJ/kg DM (megajoules per kilogram of dry matter).

Sheep use energy for a variety of bodily functions including:

- maintenance
- growth
- pregnancy
- lactation

Energy for maintenance

An animal needs energy to maintain its body and functions. The amount of energy is predominately determined by:

- liveweight
- activity – animals that must walk long distances have a higher requirement than those confined in feedlots or small paddocks
- climate – cold weather increases the maintenance energy requirement to keep warm.

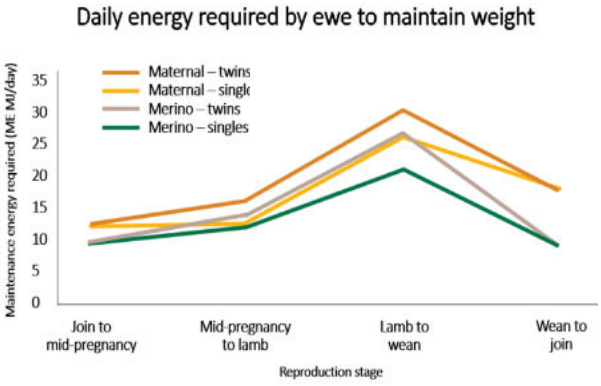


FIGURE 30: Ewe energy demand over a reproductive cycle. *(Source: Bred Well Fed Well (2023), adapted from Blumer et al (2019) and Lifetime Wool (2008).*

Energy for production (pregnancy and lactation)

Energy for pregnancy and lactation is more complex. Even if energy intake is inadequate, females cannot shut down pregnancy or milk production although the energy available for either function is reduced. Rather, they will begin to lose weight, using the energy released by mobilising their own body tissue to maintain the foetus and/or milk production. Body fat is a valuable source of energy for lactating ewes. Most breeders will lose weight in early lactation. This is why it is paramount that ewes are in good body condition coming into lambing.

It is possible to quantify based on breed and bodyweight what the maintenance energy requirement is of a ewe and then we can look at the additional energy required to grow a foetus and meet ewe pregnancy requirements. This allows us to formulate containment ewe rations that match exactly what a ewe requires to maintain, lose or put on condition at the varying stages of gestation.

Protein

Protein is required for almost all bodily functions. It is the primary source of the essential nutrient nitrogen and its level in feed or forage is expressed as a percentage.

Protein requirements vary according to age of the animal, growth rate and pregnancy and lactation status. Ewes in late pregnancy must supply protein to the rapidly growing foetus. Protein is a significant and important component of milk, therefore lactating ewes have a higher protein requirement to meet the demand of milk production. The proportion of liveweight that is made up of protein decreases as animals get older because animals begin to lay down a higher proportion of fat as they age meaning older animals that are on maintenance rations have a lower protein requirement.

There are different types of protein or nitrogen:

- **Crude protein (CP)** is a measure of the total nitrogen content of a feedstuff including true protein and non-protein nitrogen. It is calculated as 6.25 times the total nitrogen content (%) of the feed.
- **Rumen Degradable Protein (RDP)** is the portion of crude protein which can be used by ruminal microbes to convert feed nutrients to microbial protein. It can include true protein and non-protein nitrogen.
- **Undegraded Dietary Protein (UDP)**, or bypass protein, is the portion of an animal's crude protein intake that is not digested in the rumen. This fraction is mainly digested in the small intestine and is utilised directly by the animal without being converted into microbial protein (e.g., cottonseed meal and canola meal).
- **Non-protein nitrogen (NPN)** includes compounds such as urea, which are not proteins but can be converted into proteins by microbes in the rumen.

Energy is needed to drive microbial crude protein production in the rumen. The available energy and protein need to be balanced. If energy is deficient, surplus ammonia (converted from dietary protein) is not captured by the rumen microbes and is

transferred across the rumen wall, with some lost to the animal by urinary excretion. Similarly, if protein is deficient the surplus energy is used inefficiently in other metabolic processes.

As energy and protein requirements vary considerably over a breeding year and depend on the mature weight of adult animals, energy and protein charts can be a good reference point. Energy and protein requirements of sheep are shown in Table 9.

TABLE 9: Energy and protein requirements of sheep. *(Source: Making More from Sheep, 2015).*

	Dry sheep maintenance requirements			Ewe (mid pregnancy)	Ewe (early lactation)	Weaner		
	40kg	50kg	60 kg	50kg	50kg	<20kg	20–25kg	>25 kg
MJ ME/hd/day (confinement fed)	6.4	7.0	8.0	10.0	15.0	3–4	4–5	5–6
MJ ME/hd/day (grazing)	7.6	8.5	9.7	11.5	17.0	3.4–4.5	4.5–5.7	5.7–6.8
Protein min %	6–8	6–8	6–8	8–10	12–14	14–16	12–14	10–12

Note: Ewes carrying twins in late pregnancy and in lactation will have a 15% higher energy requirement than single-bearing ewes.

Fibre

The fibre proportion of plants or forage can be divided into two groups, Neutral Detergent Fibre (NDF) which is a measure of the structural components, specifically cell walls which are more digestible, and Acid Detergent Fibre (ADF) which are the least digestible parts of the plant containing cellulose and lignin. Together, ADF and NDF are the crude fibre percentage of plants or forage i.e. the total fibre content.

The fibre content of forage relates to its bulk; once the fibre levels get high, intake is restricted as the animal is full and will stop eating. NDF is an indicator of voluntary intake as it determines the amount of bulk or fill. Once fodder or rations become very fibrous it can be difficult for livestock to reach energy and protein targets as they cannot physically consume enough of the high fibre, low digestibility feed. Often fibre is used to restrict intake when energy and protein requirements are lower and as they increase a more energy dense lower fibre ration is required.

You can use the prediction equation 120/NDF = intake as a % of bodyweight to predict how much intake ewes are likely to have on high fibrous (NDF) feeds.

As, especially twin bearing, ewes get closer to lambing they have less gut space so intakes of fibrous feed starts to decrease – it's important once they get closer to lambing that they are able to access more energy dense or lower fibre feed.

As ruminants' fibre is critical in the diet of containment ewes particularly if they are on feed a long period of time and due to them returning often to paddock feed it's important that the rumen can adjust quickly back to a paddock diet.

Particle size of the fibre is critical also to stimulate 'rumen…. 'Target lengths of fibre for sheep is around 25mm or muzzle width – this is what we call 'effective fibre'. This assists to stimulate chewing and saliva production which produces sodium bicarbonate which helps buffer the rumen. Monitoring manure can help determine general rumen health and whether the ration contains adequate fibre.

FIGURE 31: Manure consistency indicating fibre content and quality of the diet. *(Source: Local Land Services 2023).*

Commonly seen when a poor-quality diet low in protein and carbohydrates, high in low quality fibre.

Stacked 'pat', solid, intact and 'weetbix' consistency. Ideal target consistency when on a grain and roughage diet.

Grey, runny manure and evidence of gas bubbles or undigested starch (white patches) indicates rumen acidosis.

Vitamin and mineral requirement

When ewes are supplementary fed, it is critical that they have a balance of vitamins and minerals also. Minerals are important for health and production in pregnant ewes as they are a key component of almost every metabolic process in the body. Macrominerals such as calcium, phosphorus and Magnesium are required in large quantities. Microminerals (or trace minerals) are required in smaller quantities along with vitamins. The feed types used in ration formulation will have different quantities of vitamins and minerals contained in them so it's important to supplement where required along with the containment ration. An overview of sheep mineral and key vitamin requirements is shown in Table 10.

TABLE 10: Vitamin and Mineral Dietary Requirements for Sheep. *(Source: Primary industries Standing Committee, 2007 and Ruminant Nutrition, 2006).*

Mineral	Dietary requirement g/kg DM
	Sheep
Calcium	1.4–7.0
Phosphorus	0.9–3.0
Chlorine	0.3–1.0
Magnesium	0.9–1.2
Potassium	5.0
Sodium	0.7–1.0
Sulphur	2.0
Micro Mineral	**Dietary requirement mg/kg (or ppm)**
	Sheep
Cobalt	0.08–0.15
Copper	4–14
Iodine	0.5
Iron	40
Manganese	20–25
Selenium	0.05
Zinc	9–20
Vitamins	**Dietary requirement (IU/Kg DM)**
	Sheep
E	10 - 20
A	4300 – 8000 (Lactating Ewe)
B1 (mg/Kg)	2 (5 – 10 with PEM problem)

Macrominerals

Calcium

Calcium is important for nerve function, muscle contraction, blood clotting, activation of a number of enzymes and bone formation. A ewe's calcium demand increased during the last two months of pregnancy and during early lactation, due to an increased demand for calcium during bone development in the foetus and lamb. Calcium is typically low in grain and cereal hay diets and they are generally excessive in phosphorus. High grain diets for more than 6 weeks (and this is aggravated further by grazing stubbles and consuming calcium deficient diets prior to entering containment) are prone to causing hypocalcaemia. Bone is the main store of calcium, however it can be insufficient during late pregnancy and lactation when calcium requirements is almost doubled. Single bearing ewes

require 3 – 4 grams/kg DM of calcium a day, twin bearing ewes will need 5 – 6 grams/kg DM of calcium a day which can be provided with a supplement.

Magnesium

Magnesium is important for moderating nerve impulses, bone formation and energy reactions. Approximately 70% of the body's magnesium is stored in the skeleton but it is poorly mobilised by adult stock. Magnesium deficiency often occurs on pasture that is high in nitrogen and potassium so fodder harvested from these pastures can be an issue in containment. If Calcium intake is excessive in comparison to magnesium it can also cause a deficiency. Magnesium supplementation can assist with muscle function over lambing and helps to avoid Hypomagnesaemia when ewes are in late gestation.

Phosphorus

Most fodder and grains fed in containment are likely to be high in phosphorus. Phosphorus and calcium are both involved together in bone metabolism.

Calcium: Phosphorus ratio

Often the calcium to phosphorus ratio is not high enough in containment rations (which is why we concentrate on calcium supplementation. The recommended ration is between 1.5 and 2 to 1.

All cereal grain, pulses and processed meals have lower calcium to phosphorus ratios than recommended. Hays and silages can have slightly more calcium than phosphorus with legume hays having higher calcium than cereal hays.

Potassium, calcium and magnesium

A diet can be measured for 'grass tetany risk' by calculating the ratio of potassium to total calcium and magnesium (K/(Ca + Mg)). If the ratio is greater than 2.2 then the risk of grass tetany and/ or hypomagnesaemia is high. Low magnesium or calcium produces low blood serum magnesium or calcium. High potassium also has an antagonist effect on magnesium concentrations and absorption. Cereal grains and crops are also deficient in sodium which exacerbates the impact of potassium on magnesium absorption. Depending on the ration calcium, sodium and Magnesium can all be critical in a supplement program.

Microminerals

Cobalt

Rumen microorganisms need cobalt to make vitamin B12. Cobalt deficiency can result in appetite loss, lethargy, reduced growth and weight loss.

Copper

Copper is found in body tissues and organs. Copper deficiency is most common on sandy soils, symptoms include spontaneous bone fracture, decreased growth rate and steely wool.

Manganese

Manganese is found in all ruminant tissues with concentrations in the liver, kidney, bone, pancreas and pituitary gland. Manganese deficiency can impair reproductive function, result in deformed bones with large joints, severely decreases growth and feed intake.

Selenium

Selenium is found in blood plasma and in cells. Selenium deficiency is more commonly associated with sandy coastal soils. Deficiency will cause a stiff gait and white muscle disease, heart failure, paralysis, ill thrift and decreased wool growth.

Zinc

Zinc is found in many body tissues, but its highest concentration is in the liver, bone, kidneys, muscle, pancreas, eye, prostate, skin, hair and wool. Zinc deficiency can cause dermatitis, reduced immune system and wound healing, retarded growth and bone formation and impaired reproductive performance.

Vitamins

Vitamins are needed for normal function growth and maintenance of body tissues.

B-Vitamins

B-vitamins are Water soluble vitamins that are required daily. During fermentation, rumen bacteria synthesise, absorb and use these vitamins. Anything that interferes with normal rumen function i.e. acidosis, worms, severe stress or disease or reduced feed intake can interfere with microbial activity and reduce B-vitamin synthesis. A functional rumen should supply adequate levels of all B vitamins. Rumen bacteria can produce vitamin B12 but requires cobalt. Cobalt deficiencies can occur on sandy soils, during rapidly growing spring grass or on cereal pastures.

Vitamin C

Vitamin C is an antioxidant, it helps to prevent cell damage and in doing so helps to fight infections, heal wounds, and keep tissue healthy. Ruminants synthesise vitamin C, so it's not required as a supplement.

Vitamin A

Vitamin A is produced by conversion of carotene found in green, leafy forages. It is needed for normal bone growth and development, regulation of cell growth reproduction and light transmission to the brain. Deficiencies occur when stock are supplementary fed and haven't had access to green feed for a period of time especially in young stock. If they have had access to green feed for more than three months in a season older stock can store adequate levels of vitamin A in the liver.

Vitamin D

Vitamin D2 is available in sun cured forage i.e. hay, and vitamin D3 from exposure of the skin to ultraviolet light. The requirements for vitamin D increases when either calcium or phosphorus in the diet is low. Vitamin D deficiency isn't common, but supplementation may be required for stock kept inside, or during winter months if stock are on green forage (high carotene).

Vitamin E

Vitamin E is an antioxidant important for maintaining cell membranes. The major source for sheep are green feeds. Vitamin E is poorly stored in the body so daily intake is needed. Vitamin E deficiency occur when feeding hay or grain over extended periods of time and can also be common in fast growing lambs. It can also be more common if stock are fed high grain rations with limited or no roughage.

Vitamin K

Vitamin K is common in feeds and able to be synthesises by rumen microbes, animals aren't usually deficient in this vitamin.

Buffers or other feed additives

Other additives that can be included in confinement rations can assist with the management of acidosis, mycotoxins in feeds, dust and can include protein.

Acid Buf

A natural buffer that is derived from seaweed, it also contains calcium and magnesium. Acid Buf works to reduce the risk of acidosis and optimises rumen pH. It is a more effective buffer than sodium bicarbonate as it continues to buffer at a lower rumen pH. Typically, is added at 1% of feed weight on introduction of starch-based feeds.

Sodium Bicarbonate (bicarb soda)

An alkaline that is naturally produced by stock in their saliva, which can assist with buffering against acid production. It's buffering ability is reduced once rumen pH drops below 6. Generally added at 2% of the feed weight.

Bentonite

A clay that swells when exposed to moisture (i.e. rumen fluid) slowing down the digestion process. Bentonite isn't a true buffer but binds acid 'positive ions' and removing them from the rumen in the manure, can also help with scours and deactivates some moulds and toxins. As it is a clay it can also reduce feed intake. Is commonly used at 3 – 4% when introducing stock to grain.

Ionophores (i.e. Bovatec)

A rumen modifier that inhibits the growth of specific rumen microorganisms and improving feed efficiency. Bovatec (Lasalocid) is also registered for the control of coccidiosis in sheep. It is considered an 'antibiotic' in some cases so can't be used if selling stock as meat into these markets.

Molasses, Molafos and Vegetable Oil

Are generally all used to reduce dust within a total mixed ration. All can be used as an energy source also. Generally used at 1 – 2% of the ration.

Urea

Urea or slow-release urea products (i.e. Optisync) is an NPN (non-protein nitrogen source). It isn't a protein source but is converted to protein by microbes in the rumen. Urea can be handed to rations in small quantities if extra protein is required by the animal and this is the most cost-effective form.

SUPPLEMENTATION METHODS AND FEED FORMULATION

Supplementation methods

Ewes can be supplemented either within the ration depending on the presentation of the ration. In a TMR mix you can add a powdered or pelleted mineral and vitamin additive product to prevent any deficiencies. If grain is being fed alone a pelleted formulation is a better option as it prevents sifting out of a powdered product and can be easily mixed evenly with the grain ration. The other option is a loose lick being provided ad-lib in the pen for ewes to moderate their own intake.

Supplements can be either commercial preparations, customised dependent on the deficiencies within the ration or simple home-made mixes.

Feed components

Feed testing

It's critical to feed test any feed ingredients or look at the nutritional specifications (pellets) to determine what the fodder is likely to provide. Cereal grains, pulses and fodder sources often vary from year to year so it's important to test each season. The major nutritional information of value will include dry matter content of the feed type, digestibility, energy, protein, ndf (neutral detergent fibre) and starch level.

Feed testing can be done at:

- Feed test: FeedTest – hay, feed and fodder testing for livestock
- Forage Labs: Forage Lab Australia. Accurate, fast feed test for livestock.

Grain

Grain is an effective containment feeding option in conjunction with a fibre source. Cereal grains (commonly wheat, triticale, barley and oats) are energy dense and most of the energy is stored as starch, they will contain varying protein, vitamins, minerals and fibre also. Generally cereal grains are the cheapest form of energy in a ration but more expensive as a way of adding protein. An overview of the energy, protein, starch, fibre and oil content of common grains is provided in Table 11.

Pulses (lupins, peas and beans) and processed meals (canola, cottonseed, soybean) are used primarily to improve protein levels within a ration. They are generally the best priced per unit of protein but often more expensive per unit of energy.

There is no advantage to processing grain for sheep. Trial work has repeatedly shown that feeding whole grain can increase intake and growth rates; improve feed conversion efficiency and reduce acidosis risk (Local Land Services 2023).

Grain is often quite imbalanced to deliver mineral requirements of ewes.

TABLE 11: 'Average' energy, protein, starch, fibre and oil content of common cereal and pulse grains (Local Land Services 2023).

Grain	Energy (Mj/kg DM)	Protein (%)	Starch (%)	Fibre (%)	Oil (%)
Wheat	13.5	13 %	76%	2-3%	1-2%
Triticale	13.0	13%	76%	2-3%	2-3%
Corn	13.0	8%	76%	2-3%	2-3%
Sorghum	13.0	12%	70%	3-5%	3-4%
Barley	13.0	12%	61%	5-7%	1-2%
Oats	12.0	10%	42%	12-25%	7-10%
DDG *	12.5	25%	6%	6-8%	4-5%
Cottonseed	13.0	22%	38%	18-24%	12-16%
Lupins	13.0	35%	<10%	10-15%	5-9%
Peas	12.5	25%	48%	9%	0.5%
Beans	12.5	25%	37%	11%	1.5%

* DDG = Dry Distiller Grains. A nutrient rich co-product of dry-milled ethanol production.

Pellets

Pellets can be a useful addition to a containment feeding ration. There are various specifications of pellets on the market so it's important to look over the nutritional specification carefully.

Complete feed pellets are the most common full feed pellets on the market to supply high quantities of energy and protein. They often incorporate cereal grains, pulse grain or meals, urea, roughage and mineral additives. Often grain is processed to go into these pellets which can increase acidosis risk, it's important that they also contain a reasonable buffer and adequate fibre. A more concentrated energy dense pellet with limited fibre can also be used as a replacement for grain. As the fibre in pellets is often not 'effective fibre' i.e., the particle size is not adequate, a more concentrated pellet can be used in place of grain with an effective fibre source (like hay or straw) provided separately.

Pellets come in varying sizes, 5 – 10mm is most common for sheep and can be fed easily through a TMR or through a self-feeder. Larger pellets can be useful if ewes are being trail fed in troughs etc.

Pellets can work very well as often they are a balanced ration incorporating all of the vitamins and minerals an animal requires per mouthful with the energy, protein and fibre.

Roughage

Roughage makes up a substantial component of the ewe containment ration due to the rumen's requirement for fibre. Intakes are determined by the overall fibre content of the ration which means we can utilise roughage to enable an animal to feel full and eat throughout the whole containment period while still hitting energy and protein targets.

Straw

Often straw is fed early in the containment period as it's lower nutritional value and high fibre means ewes can be filled up without going over energy and protein targets. It can be fed in conjunction with some cereal grain if required.

Hay

Hay is often lower fibre and higher energy and protein than straw but this changes significantly from season to season. Higher quality hay such as vetch and lucerne can be a very good fit for ewes later in gestation as the NDF level is often lower than cereal hays and the protein is likely to be much higher. Cereal hay varies significantly in quality depending on what stage of growth it was cut at, variety, etc, so it's even more crucial to feed test each season.

Silage

Silage can be a useful addition to a containment ration or fed as a sole supplement depending on its nutritional specification. Similar to hay, the quality can vary season to season and depending on variety cut so it's critical to have some feed test information. Often, it's useful if you're relying on a predominantly roughage diet for containment feeding to have varying levels of quality so you can adjust the ration throughout the gestation of the ewe.

By-products

Alternative feeds and by-products can be used however it's important to compare on a cost per unit of energy and protein to determine the economics of the feed type.

By-products can include waste fruit and vegetables, peel, pulp, stem and leaf material. Alternative feeds include grain by-products, cottonseed, oilseed meals, tallow or molasses.

Before considering feeding these feed types producers need to consider:

- The feeds energy, protein and roughage value on a 'dry matter' basis and compare. Economics per unit of protein and energy with traditional feed types.
- Any digestibility, palatability, moulds, poisoning or choking risks.
- Feed availability and practicality of handling.
- Animals' acceptance of the feed type.
- Contaminants such as weed seeds.
- Mineral imbalances or animal health issues.

Starch management

Depending on the ingredients used and the starch quantity, animals may need to be introduced slowly to the ration. Cereal grains like wheat and triticale are very high in starch (approximately 76%) and would need to be introduced over a number of days to reduce the risk of acidosis. Barley is marginally safer with a slightly lower starch content with peas, oats, beans and lupins all being safer (in order from higher starch to lower starch content).

TABLE 12: Guide to introducing grain to ewes with no exposure. *(Source: Deb Scammell).*

Day	No exposure to grain (Qty/ewe/day)	Notes
1	100g	Remain on this quantity until all ewes line up to consume grain.
2	100g	
3	200g	
4	300g	
5	400g	
6	500g	
7	600g	Work up to desired daily quantity required to reach ewes energy requirement as grain quantity will increase gradually from that point until lambing as energy requirements slowly increase.
8	700g	
9	800g	
10	900g	
11	1kg	

When introduction starch-based grain products it's important to step through a slow introduction, a ration that contains barley, wheat or triticale should be introduced as shown in Table 12 working them up slowly to the quantity of grain they are going to be given in the containment pen. Ideally, they should be introduced to the same grain mix they will be fed in containment. If you are feeding a TMR you can introduce grain by doing a high fibre and low grain mix initially and then gradually increasing the grain quantity so their daily quantity is similar to that shown in Table 12.

Least cost rations

Containment ewe rations are generally formulated on a minimum cost basis dependent on the fodder available.

By looking at price per unit of energy and protein ensures ewes are fed at minimum cost while still meeting requirements. Fibre requirements also need to be met. When looking at energy dense feed alternatives like pellets can end up more expensive per unit of energy and protein (due to the pelleting process). However sometimes convenience of a feed type (and less labour requirement and health risks) can outweigh the cost difference.

Moulds and mycotoxins

Mycotoxins are secondary mould metabolites produced by certain species of fungi. They are commonly found in grain, hay and silage, and occur as a result of fungal contamination of the feed during growth, harvest or storage. Ruminants can generally cope with higher quantities of mycotoxins than monogastrics, however impacts on reproduction and production can be significant depending on the type of toxin.

Mycotoxin binders

Mycotoxin binders include products such as 'Elitox ruminant' and 'Mycosorb A+' which bind and have adsorption properties to decrease the effect of mycotoxin's in the ration. The effective binders available will alleviate the negative effects of toxins present in grains and forages.

Mycotoxin testing of forage can be done through:

- www.alltech.com.au
- https://symbiolabs.com.au
- https://neogenaustralasia.com.au

Common nutrition values

Common nutritional values of fruit and vegetables are shown in Table 13 below. Hull and husk material are shown in Table 14 and nutritional quality of the various meals is shown in Table 15.

Fruit and vegetables	Dry matter %	Crude protein %	Acid detergent fibre %	Digestible dry matter %	Metabolisable energy MJ/kg DM
Apples	49	2	9	78	12
Apple pulp	20	5	27	64	10
Banana	57	7	13	76	11
Carrots	13	10	11	70	12
Citrus pulp	18	8	25	67	10
Grape marc	51	13	61	39	6
Grape stalks	38	9	46	50	7
Lemon/orange pulp	14	9	21	69	10
Lemon peel & pulp	10	8	24	67	10
Oranges	13	7	14	70	12
Orange peel	43	9	24	68	10
Orange peel & pulp	14	8	20	70	11
Potatoes	12	10	3	70	13
Pumpkin	23	15	29	66	10
Turnip tops	10	16	25	70	10

TABLE 13: Nutritional information for common types of fruit and vegetable products. *(Source: Local Land Services 2023).*

Hulls and husks	Dry matter %	Crude protein %	Acid detergent fibre %	Digestible dry matter %	Metabolisable energy MJ/kg DM
Almond hulls	90	5	24	66	10
Barley husks	94	6	41	53	8
Cottonseed hulls	93	8	63	36	5
Oat hulls	93	4	39	53	8
Pea husks	89	12	44	52	8
Peanut hulls	91	5	78	21	3
Rice hulls	93	2	74	23	4
Sunflower hulls	92	6	63	34	5

TABLE 14: Nutritional information for common hull and husk products (A guide to confinement feeding sheep and cattle, 2023).

Processed meal	Dry matter %	Crude protein %	Acid detergent fibre %	Digestible dry matter %	Metabolisable energy MJ/kg DM
Copra meal	92	25	30	65	12
Cottonseed meal	90	40	15	80	13
Canola meal	89	39	21	75	12
Safflower meal	92	25	40	65	12
Sunflower meal	90	32	32	62	9
Soybean meal	88	49	9	90	13
Palm kernel expeller	90	17	45	72	11.7

TABLE 15: Nutritional information for common types of processed meal types (A guide to confinement feeding sheep and cattle, 2023).

Formulating rations

When formulating containment rations it's important to meet energy and protein requirements through gestation to ensure ewes hit condition score targets.

Generally, energy charts will show the energy requirement dependent on stage of gestation changing every 10 days as they get closer to lambing. Energy requirement in MJ day is shown below in the table below and is the energy required dependent on the standard reference weight (SRW) of the ewe to maintain a merino ewe in condition score 3 in paddock conditions.

When formulating containment rations it's crucial to keep fibre levels high (minimum NDF 30%). Containment rations are much different to short term high performing feedlot rations where stock are often fed lower fibre rations to increase protein and energy intakes and improve growth rates.

When ewes are in containment you can formulate to meet energy and protein targets without keeping the rumen full for the day, I prefer to feed higher fibre rations that mean ewes get a full daily intake of fibre while meeting energy and protein targets. As ewes are likely to need to adjust back to paddock feed, it's also important to keep the fibre digesting microbes in the rumen functional to assist with this transition. Containment diets that are really high in energy dense feeds such as cereal grain also can increase the risk of animal health issues in containment and over the lambing period. Mineral levels need to be considered when formulating rations to ensure all the requirements are met and the diet is balanced. Rations are often formulated on a least cost basis too by looking at ingredients available and what is likely to be the most economical way to satisfy the ewes requirements.

TABLE 16: Merino ewe energy requirements MJ/Day for different SRW at varying stages of pregnancy and lactation.
(Source: feed budget tables, lifetime wool).

SRW	50kg		55kg		60kg		65kg		70kg		75kg	
Pregnancy	single	Twins	single	twins	single	twins	single	twins	single	twins	single	twins
Dry	8.3	8.3	9.0	9.0	9.6	9.6	10.3	10.3	11.0	11.0	11.6	11.6
70	9.0	9.1	9.7	9.8	10.4	10.6	11.2	11.3	11.9	12.0	12.6	12.7
80	9.3	9.3	10.0	10.0	10.8	10.8	11.5	11.5	12.3	12.3	13.0	13.0
90	9.5	9.8	10.3	10.6	11.0	11.4	11.8	12.2	12.5	12.9	13.3	13.7
100	9.5	10.5	10.3	11.3	11.0	12.2	11.8	13.0	12.5	13.9	13.3	14.7
110	10.0	11.2	10.8	12.1	11.6	13.0	12.4	13.9	13.2	14.8	14.0	15.7
120	10.6	12.1	11.4	13.1	12.3	14.0	13.1	15.0	14.0	16.0	14.8	16.9
130	11.2	13.1	12.1	14.1	13.0	15.2	13.9	16.2	14.8	17.3	15.7	18.3
140	12.0	14.0	13.0	15.1	13.9	16.2	14.9	17.4	15.8	18.5	16.8	19.6
150	12.7	14.8	13.7	16.0	14.7	17.2	15.7	18.4	16.8	19.5	17.8	20.7
Lactation												
1	12.5	14.4	13.5	15.6	14.5	16.7	15.5	17.9	16.5	19.0	17.5	20.2
10	18.7	23.4	20.2	25.3	21.7	27.1	23.2	29.0	24.7	30.9	26.2	32.8
20	20.7	26.6	22.4	28.7	24.0	30.9	25.7	33.0	27.3	35.1	29.0	37.2
30	20.2	25.8	21.8	27.9	23.4	29.9	25.0	32.0	26.7	34.1	28.3	36.1
40	18.6	23.4	20.1	25.3	21.6	27.1	23.1	29.0	24.6	30.9	26.0	32.8
50	16.7	20.6	18.0	22.2	19.4	23.9	20.7	25.5	22.0	27.2	23.4	28.8
60	14.9	18.1	16.1	19.5	17.3	21.0	18.5	22.4	19.7	23.9	20.9	25.3
70	14.1	15.8	15.2	17.1	16.4	18.3	17.5	19.6	18.6	20.9	19.7	22.1
80	13.4	13.9	14.5	15.0	15.5	16.1	16.6	17.2	17.7	18.3	18.8	19.5
90	11.0	12.4	11.9	13.4	12.8	14.4	13.6	15.4	14.5	16.4	15.4	17.4
100	10.2	11.2	11.0	12.1	11.8	13.0	12.6	13.9	13.5	14.8	14.3	15.7

HEALTH AND WELLBING OF SHEEP IN CONTAINMENT

A successful containment feeding program can be achieved with correct management. As stock are being managed more intensively there is some risk of health problems. The most common issues are described below.

Acidosis (grain poisoning)

When ewes eat too much grain rapidly or it is not correctly introduced to their diet it can ferment in the rumen and damage the microflora in the foregut (rumen). It produces lactic acid and other toxins that are absorbed into the blood stream causing endotoxic shock syndrome.

FIGURE 32: Grain in the rumen of an acidosis affected sheep. *(Source: Sheep disease, a farmer's guide, 2022).*

Cause

Inadequate introduction of high starch feeds e.g. wheat or barley.

Symptoms

- Signs occur within 24-36 hours of sudden grain introduction.
- Mildly affected animals may have diarrhoea but continue to eat.
- They become restless getting up and down or spend more time lying down.
- More severely affected may stop eating, become sore footed or grind teeth.
- In severe cases death can occur.

Treatment

- Remove grain from diet.
- Supply good quality hay and plenty of fresh drinking water.
- Veterinary treatment – supportive care, fluids, Bicarb soda to increase rumen pH.
- In some instances, on veterinary advice antibiotics might be indicated.

Metabolic diseases

Pregnancy toxaemia (ketosis, twin lamb disease)

Pregnancy toxaemia is common in multiple bearing ewes during late pregnancy and is caused by a lack of energy. It is caused by low blood sugar (glucose) which results in the breakdown of fat to provide energy. The mobilisation of fat can cause production of toxic levels of ketones circulating in the blood.

Cause

- Inadequate nutrition in the last 2 months of pregnancy to meet ewe requirements.
- Any sudden restriction of feed during late pregnancy (i.e. around crutching, shearing or poor weather).
- Over fat ewes that aren't meeting nutritional requirements are more at risk.

Symptoms

- Dullness, anorexia, nervous signs and lagging behind the mob when driven.
- May appear dull or not move when approached or stumble and collapse.
- Sit down with vacant looking expression on their face.
- Can eventually become comatose and die.

Treatment

- Treatment must occur as soon as clinical signs occur.
- Supply glucose and hydration such as Vytrate and Ketol (propylene glycol) given orally – available from vets or rural stores.
- Repeat administrations are usually necessary.
- Ewes not responding to treatment may need to be humanely euthanased.

Hypocalcaemia (milk fever)

Milk fever occurs in pregnant ewes when there is insufficient dietary intake, absorption or insufficient resorption from skeletal reserves to meet the foetal demands. It is often complicated by low blood magnesium and phosphorus levels. Most common in late pregnancy or just after lambing. Low calcium levels can occur sub-clinically where ewes appear normal but lambs born to these ewes have a poorer change of survival.

FIGURE 33: A ewe suffering from Hypocalcaemia – they often go down with their head turned around to their flank. *(Source: Sheep disease, a farmer's guide, 2022).*

Cause

- Low level of calcium in the blood due to inadequate supply, absorption or resorption from skeletal reserves
- Predisposing factors – sudden changes in feed late pregnancy, holding in yards for crutching or shearing or mustering or moving ewes late pregnancy.
- Anything that causes a short-term starvation late pregnancy is a predisposing factor.
- Up to 2.8 g of calcium per day is required to meet foetal needs.
- Hypocalcaemia occurs when blood levels of calcium fall below 1.7 mmol/l.

Symptoms

- Initially ewes appear wobbly and hyperexcitable.
- Progresses rapidly to sternal recumbency, head turned to the side and then comatose.

Treatment

- Rapid administration of injectable calcium products at the correct dose rate in the early stages of disease.
- These products are often in combination with magnesium and glucose (e.g. Flopak Plus 4 in 1)
- Care with rapid IV administration, which can lead to cardiac arrest.
- Ewes often show rapid response and can stand and urinate in 15-30 minutes.

Prevention

- Avoid stressful conditions for ewes late pregnancy.
- Ensure adequate supplementation of calcium in rations during gestation.
- Often pregnancy toxaemia and hypocalcaemia can be confused. Table 17 above shows how to diagnose between the two.

Difference between pregnancy toxaemia and hypocalcaemia

Pregnancy toxaemia	Hypocalcaemia (milk fever)
Gradual onset	Sudden onset
Sheep appear dull	Sheep appear alert but may stagger or convulse
Sheep are unresponsive when approached	Sheep move or struggle when approached
Death occurs within 5-7 days	Death occurs within 24 hours
Poor response to treatment	Good response to treatment

TABLE 17: The difference between pregnancy toxaemia and hypocalcaemia. *(Source: Sheep Disease, a farmers guide, 2022).*

Hypomagnesemia

Sheep develop low levels of magnesium in their blood which is essential in the body for nerve transmission as well as a lot of other vital functions. Most common in pregnant ewes or within six weeks of lambing. There is no adequate store of magnesium in the body, so animals are dependent on a continued dietary intake to meet their requirements. Can be seen in situations where potassium fertilizers are applied making the magnesium in pasture less readily available. Lush Green pastures are low in magnesium so ewes grazing these pastures post lambing are of higher risk.

FIGURE 34: Ewe death associated with hypomagnesaemia. *(Source: Sheep disease, a farmer guide, 2022).*

Cause

- Inadequate magnesium supply in pastures or rations to meet the ewes needs.
- Especially common post lambing.

Symptoms

- Nervous signs - excitability, incoordination, shaking and muscle tremors.
- Progress to recumbency and paddling and can froth at the mouth or have convolutions.
- Measurement of magnesium in eye fluid can aid in diagnosis.

Treatment

- Administration of injectable products containing magnesium at the correct dose rate as soon as symptoms occur e.g. Flopak Plus (4 in 1)– usually contain Ca and Mg and glucose and available form vet or rural stores.

Prevention

- Avoid moving or stressing ewes in late pregnancy or with lambs at foot.
- Supplementation – lambing licks or magnesium oxide sprayed on hay.
- Supply hay when ewes are grazing fresh green pastures.

Parasitic diseases

Worm burdens

Large burdens of intestinal round worms can cause scouring, ill thrift and lead to weight loss and sometimes sudden death. There is a higher risk in maiden ewes or in situations of over-crowding or where pastures/yards are repeatably used each year.

Cause

- Round worms or nematodes – the most important in Australia being barbers pole worm, black scour worms and the brown stomach worm.

Symptoms

- Scouring
- Weight loss and poor growth rates
- Bottle jaw, pale gums and anaemia and lethargy
- Occasional deaths

Diagnosis

- Faecal egg counts or worm counts at post-mortem.
- Larval culture can give indication of what type of worm is a problem.

Treatment

- Drench with appropriate chemical drench orally.
- The type of drench will depend on how severe the worm burden, the class of sheep, if they are new to the property and what previous drenches have been used.
- A faecal egg count reduction test or drench test can be carried out to see that the drench works or if the worms have resistance to the drench given.

Coccidiosis

A condition that affects mainly lambs during times of stress such as before or after weaning, transport or in over-crowded conditions. Can cause lethargy, poor appetite, scouring and sometimes sudden death.

FIGURE 35: Coccidiosis affected lamb.
(Source: Sheep disease, a farmer's guide, 2022).

Cause

- Caused by a protozoan parasite that damages the intestinal wall.

Symptoms

- Loss of appetite and weakness
- Weight loss
- Scouring, often dark brown often with blood in it

Treatment

- Sulphadimidine can be given by injection or drench on veterinary advice. Often needs to have two doses three days apart.
- Hydration and supply of electrolyte therapy to replace lost fluids.

Prevention

- Minimise stressful conditions.
- Avoid over-crowding and maintain good hygiene standards.
- Avoid concurrent diseases including intestinal worms.
- Bovatec (ionophore) is registered to control coccidiosis in intensive environments.

Other disease conditions

Polioencephalomalacia (PEM)

An acute disease that affects the central nervous system of sheep due to an induced thiamine (vit B1) deficiency. It can affect sheep of all ages but has highest incidence in sheep 2-12 months of age. It is associated with a change in feed where less roughage is provided so there is a build-up of bacteria in the gut that produce enzymes that destroy thiamine.

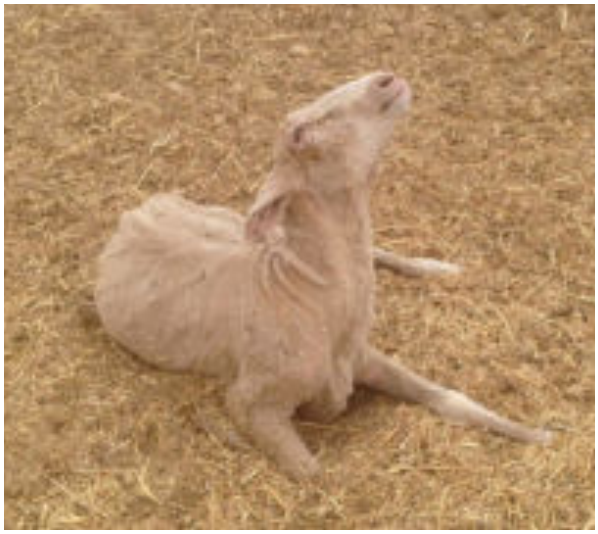


FIGURE 36: An animal star gazing associated with PEM. *(Source: Sheep disease, a farmer's guide, 2022).*

Cause

- Diets high in grain where inadequate roughage is supplied causes an overgrowth of bacteria in the gut which produce enzymes that breakdown thiamine.
- Feeds high in sulphur may be an increased risk.
- Grazing bracken or other plants that contain thiaminases also are an increased risk.

Symptoms

- Mildly affected sheep may appear blind, wander aimlessly.
- Can appear listless or reduced appetite.
- Severely affected sheep are found lying on their side with their head bent back in a "Star Gazing' posture.
- Eyes can flicker back and forth, or they can have convulsions.

Treatment

- Supplementation with Thiamine or vitamin B1 injections available from veterinarians or some rural stores.
- Sheep should respond very quickly.
- Sheep that do not respond are likely to have permanent brain damage and so would be humanely euthanased.

Prevention

- Thiamine power can be supplemented in drinking water in high-risk situations.
- Vitamin B1 can be supplied in loose licks or additives to the grain ration.

Anal prolapse

Anal or rectal prolapse occurs when the mucosa of the rectum becomes everted and extends out past the anus. There is a relationship between short tail docking and the incidence of anal prolapse, possibly due to some loss of control of the anal sphincter muscles.

FIGURE 37: An anal prolapse. *(Source: The Sheep, 2017).*

Cause

- Short tail docking an exacerbating factor.

Symptoms

- The rectal mucosa appears as a pink flesh balloon extending from the anus.

Treatment

- Often needs surgical correction.
- Cleaning with appropriate disinfectant and then a purse-string suture placed around the anal sphincter that can be removed in approximately 7 days.

Prevention

- Care should be taking in docking lambs that the tail is removed below the 3rd palpable joint (5th coccygeal vertebrae). So approx. 5 cm of tail remains, or the tail covers the vulva in ewe lambs.

Vaginal prolapse

Prolapse of the vaginal can occur in pregnant ewes usually in the terminal stages of pregnancy but also in non-pregnant ewes. It sometimes can have an unusually high incidence in some seasons or on some farms but the exact cause is unknown.

FIGURE 38: A vaginal prolapse. *(Source: The Sheep, 2017).*

Cause

- The exact cause is unknown however here appear to be some pre-disposing factors and the incidence on some farms tend to be higher than on others.
- Predisposing Factors include twin bearing ewes in good body condition, ewes on moderate to steep terrain, grazing oestrogenic pastures e.g. subterranean clovers and can be associated with poor quality feed and hypocalcaemia.

Symptoms

- The protrusion of some part of the vaginal mucosa between the lips of the vulva
- In later stages the whole vagina protrudes everted and appears as a pink fleshy balloon between the lip of the vulva.

Treatment

- Treatment in earlier stages is most successful.
- Careful cleaning with a dilute disinfectant agent and lifting the everted tissue to allow the trapped urine to pass.
- Hind legs can be elevated to aid in replacing everted tissue.
- In severe cases where the tissue is badly infected or dark in colour and not viable the animal may need to be euthanased.

Bacterial diseases

Pinkeye

Pinkeye is a severe eye infection or conjunctivitis that can cause temporary blindness. Can be particularly a problem if it occurs in late pregnant ewes making feeding difficult increasing the risk of pregnancy toxaemia.

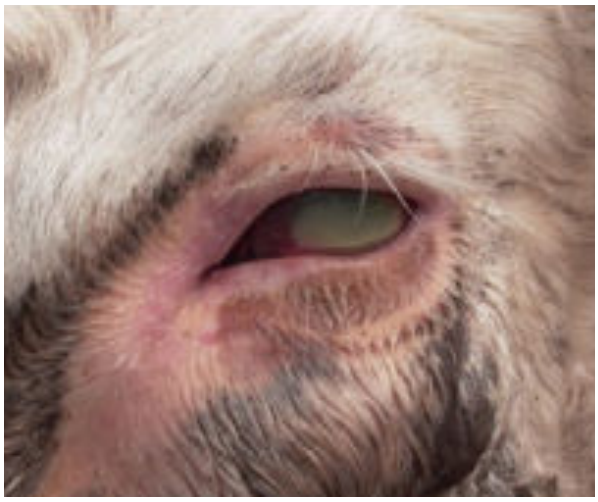


FIGURE 39: Pink eye affected animal.
(Source: Sheep disease, a farmer's guide, 2022).

Cause

- Caused by groups of bacterial agents that infect and cause inflammation of the eye.
- Chlamydophila species, Mycoplasma species or Rickettsia conjunctivae are some of the causative agents.
- More common in dusty conditions in summer and autumn.
- Can be spread via dust, pollens and flies.
- May persist in carrier animals for up to a year which act as a source of information in subsequent years.

Symptoms

- Sometimes self resolves, however fast treatment leads to rapid resolution of symptoms.
- Eye is inflamed and red – conjunctivitis.
- Excess weeping or tearing of affected eye, appears as a wet face.
- Ewe will be sensitive to light.
- Progresses to bluing of the eye or a film appearing over the surface of the eye.
- Severe untreated infections can progress to eye rupture.

Treatment

- Check eye first for grass seeds as symptoms are very similar.
- Use an appropriate eye medication such as topical oxytetracycline puffer or spray.

Prevention

- Prevent moving ewes in very dry dusty, hot conditions or holding in very dusty pens.
- Avoid over-crowding.

Pulpy kidney

A clostridial bacterial disease that can occur in sheep of all ages when there is a sudden change in diet. It usually presents as sudden death, often of animals in good condition.

FIGURE 40: Kidney of an animal affected with pulpy kidney. *(Source: Sheep disease, a farmer's guide, 2022).*

Cause

- Pulpy kidney is caused by the overgrowth of the normal inhabitant Clostridium perfingens typeD and the production of lethal toxins.
- Sudden changes in diet or increasing plane of nutrition can be a predisposing factor to the bacterial overgrowth.
- Bowel stasis due to inadequate roughage supplied in feed can also increase risk of disease.

Symptoms

- Affected sheep are often found dead due to the rapid onset of disease.
- Sheep do not survive more than 24 hours.
- Initially dullness, then rapid decline recumbency, convulsions and frothing at the mouth.
- Can be diagnosed by typical findings on post mortem examination and laboratory histological analysis.

Treatment

- No effective treatment, prevention is the key to this disease.
- Prevention
- An appropriate vaccination protocol with a clostridial vaccine
- Last dose of vaccine should be at least 10 day prior to heavy grain feeding during containment.
- Avoid sudden diet changes and ensure that grain is introduced correctly.

Pneumonia

A disease that causes breathing difficulties due to infection and/or inflammation of the lungs. Can cause production losses or in severe cases death.

FIGURE 41: Dark consolidated lungs on a pneumonia affected animal. *(Source: Sheep disease, a farmer's guide, 2022).*

Cause

- Bacterial or viral causes.
- Sheep with compromised immunity most at risk.

Symptoms

- Coughing or nasal discharge.
- Inappetence or lagging behind the mob when mustering.
- Often only the most severely affected show signs but many are sub-clinical affected and production losses occur (tip of Iceberg)

Treatment

- Severe cases might require antibiotics on veterinary advice.
- Diagnosis on post-mortem – lung consolidation (doesn't float in water).

Pleurisy (lung adhesions) can be detected at the abattoir and suggest a sub-clinical flock problem.

Prevention

- Slowly muster sheep.
- Avoid moving sheep in hot dusty conditions.
- Avoid stress factors such as overcrowding and mixing mobs, sudden diet changes.

Campylobacter (Zoonosis)

It is a Zoonotic disease that can be passed onto handlers – take care on handling aborted material.

Campylobacter is a bacterial organism that is the most common cause of abortion in sheep. Abortion usually occurs in the last 6 weeks of pregnancy but can cause early neonatal loss. In most causes the ewe remains healthy but in a small number of cases the aborting ewe may develop infection of the uterus or severe illness. Following infection ewes remain fertile and are immune to infection in subsequent years.

Campylobacter survival in soil and faecal material varies from 2 – 14 days depending on temperature, atmosphere, moisture and faecal material or soil make up. Maximum survival is at temperatures of between 10-20°C in association with high rainfall.

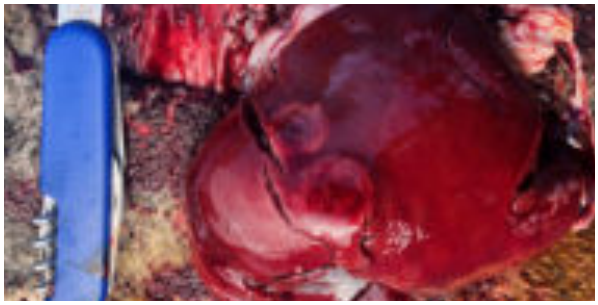


FIGURE 42: Patches on the liver of aborted foetus.
(Source: Sheep disease, a farmer's guide, 2022).

Cause
- Campylobacter abortion is caused by a bacterial agent Campylobacter fetus.
- It is transferred by ingestion of contaminated feed or water or direct contact with aborted material.
- Introduced ewes acting as a carrier can lead to a sudden abortion storm in maidens or other ewes that may have no immunity.

Symptoms
- Abortion, blood-stained breech wool of ewes or aborted material found in yards of paddocks.
- More common in maiden ewes.
- More common after the first 3 months of pregnancy.
- Post-mortem examination of the aborted foetus or foetal membranes.
- Characteristic pale while/yellow small circular liver lesions.
- Culture of organism from foetal stomach contents or foetal membranes.
- Serial blood sampling of aborted ewes.

Treatment
- On veterinary advice possible antibiotic treatment in face of an outbreak

Prevention
- Vaccination (Ovilis Campyvac; Coopers Animal Health) in flocks where campylobacter is a problem – particularly for maiden ewes, ewe lambs or any ewes that may not have had earlier exposure. Recommended vaccination program is: **1st dose:** Up to 8 weeks prior to joining; **2nd dose:** 3 – 8 weeks after first dose. Annual booster before joining for previously vaccinated ewes.
- Avoid overcrowding.
- Removing stock from contaminated yards or pastures.
- Care with hygiene and moving infected material between flocks on clothes or footwear.
- Though that birds may risk introducing campylobacter into a flock.

Viral diseases

Scabby mouth (Zoonosis)

It is a Zoonotic disease that can be passed onto handlers and presents as ORF in humans.

Scabby mouth is a highly contagious viral disease. In some flocks the incidence can be as high as 90%. It is usually a self-limiting disease but can affect growth rate of lambs and hoggets due to oral pain, causing reluctance to graze or suckle. Greater incidence in sheep grazing pastures with prickly weeds such as thistles or blackberry.

FIGURE 43: Scabby mouth.
(Source: Sheep disease, a farmer's guide, 2022).

Cause
- A parapoxvirus in the family poxviridae that is passed between sheep or picked up from grazing pasture or feeds provided in containment.

Symptoms
- Dry sometimes proliferative scabs can be found on the lips particularly the lip margins.
- Can also affect the tongue and in severe cases cover the entire muzzle, head and ears.
- Can occur on udders in ewes with suckling lambs.

Treatment
- Treatment is not usually necessary as in most animals the disease resolves by itself in a few weeks.
- In severe cases where secondary bacterial infections occur a topical antibiotic or possibly injectable antibiotic may be indicated on veterinary advice.

Prevention
- A vaccine (Scabigard; Zoetis) is available which can be used on farms where it occurs frequently and affects growth rates.
- Control of prickly weeds

RELEASING STOCK FROM CONTAINMENT

The transition from containment feeding to pasture must be managed carefully, particularly in pregnant ewes to avoid animal health issues. In wool producing ewes the transition becomes even more critical to prevent wool quality being affected.

When to release

When determining if ewes can be released from containment the first consideration is if there is a sufficient quantity of feed to support the class of sheep.

- Dry sheep shouldn't be released from containment without supplementation until a minimum of 500kg DM/Ha (dry matter per hectare) is available.
- Ewes in late pregnancy shouldn't be released without supplement until a minimum of 1000kg/ha of pasture is available, higher feed on offer (FOO) is desirable for twin bearing ewes.
- Ewes at the point of lambing or in lactation should not be released from containment without supplementation until a minimum of 1200kg DM/ha is available for single bearing ewes and 1500kg DM/ha for multiple bearing ewes (AWI, 2019).

Pasture growth rates and quality also need to be assessed to determine if nutritional requirements can be met and what stocking rate lambing paddocks can be stocked at. Unfortunately, sometimes the pasture quality and quantity are not sufficient but ewes are getting closer to lambing. As releasing sheep from containment results in a diet change and some stress as they are mustered and moved to their paddock it's important to do this well before lambing if possible. For twin bearing ewes it's recommended to release from containment 2 – 4 weeks prior to lambing if possible. Single bearing ewes can be moved later if required, but ideally lambing paddocks shouldn't be too far from the containment pens if ewes end up being moved during very late gestation.

Managing the release

Sudden changes in feed, especially releasing stock onto high quality pastures can increase the risk of pulpy kidney. Stock ideally will need to be vaccinated with a 3 in 1 or 6 in 1, at least 10 days prior to release.

Animals should be released onto the pasture late in the day, so they are not hungry and have filled up on the containment ration. It is also advised to provide high quality ad-lib hay prior to and after release to prevent gorging of the pasture. If possible (and ewes are not close to lambing) ewes can moved onto pastures for a short period of time and built up over time to reduce the sudden transition and feed change. If this isn't possible supplementing ewes with the containment for at least a week can assist with a gradual transition.

By carefully managing the transition back to pasture impacts on wool quality can be reduced. If nutrition changes suddenly, it's possible to get a sudden change in wool diameter which can give a wool break around that time. Many producers otherwise containment feed ewes immediately off shears to reduce dust in the wool and to reduce the impact of a mid-staple wool break.

FURTHER READING AND RESOURCES

Further reading

Establish shelterbelts with multiple benefits – ANU Sustainable Farms (Sustainable farms, 2018)

standard-reference-srw-calculator-3.pdf (wool.com)

References

Australian Sheep enterprise, sheep digestive system: Digestive System - Animal Productive Systems Assignment (weebly.com)

A guide to confinement feeding sheep and cattle in NSW, 2023. LLS_confinement-feeding-booklet-web.pdf

AWI, Standard reference weight calculator. https://www.makingmorefromsheep.com.au/ko/manual/module-10-wean-more-lambs/tool-10-7-standard-reference-weight-calculator/

AWI, 2019; Releasing sheep from containment feeding. https://www.wool.com/globalassets/wool/land/drought-resources/accordion-3/releasing-sheep-from-containment-feeding-v3.pdf

Blumer, S; Behrendt, R; Hocking Edwards, J; Young, J & Thompson, A: Lifetime maternals phase 2: Feeding standards for maternal ewes, 2019.

Coopers Animal Health: Ovilis Campyvax. Ovilis Campyvax - coopersanimalhealth-com-au

DPI (Department of Primary Industries) NSW 2014. Water requirements for sheep and cattle. Primefact 326 (3rd edition). Water requirements for sheep and cattle (nsw.gov.au)

DPI (Department of Primary Industries) NSW 2014. Water for livestock: interpreting water quality tests. Primefact 533 (2nd edition) Water for livestock: interpreting water quality tests (nsw.gov.au)

Lifetime wool, 2006: https://www.lifetimewool.com.au/

Lifetime wool ewe management handbook, 2007. Available at: EwemanagementHRZeditionweb.pdf (lifetimewool.com.au)

Moriarty EM, Mackenzie ML, Karki N, Sinton LW. Survival of Escherichia coli, Enterococci, and Campylobacter spp. in sheep feces on pastures. Appl Environ Microbiol. 2011; 77: 1797–803.

Making More from Sheep, 2015, (Australian Wool Innovation Limited and Meat & Livestock Australia). Available at: Making More From Sheep - Home

Nutrient Requirements of Domesticated Ruminants, 2007, PISC (Primary industries standing committee), CSIRO Publishing, Melbourne, Victoria.

Ruminant Nutrition, 2006, Distance Education Program, Dr Paul Cusack.

Sheep Diseases: The farmers' Guide, 3rd Edition; July 2022

Summary of trigger point workshops to assist in making containment feeding decisions, June 2023.

The Sheep: Health, disease and Production (2017): DM West, AN Bruere and AL Ridler

Source: BWFW (2023), adapted from Blumer et al (2019) and Lifetime Wool (2008)

APPENDICES

APPENDIX 1: Steps to create a decision matrix

Some decisions in farming are hard. This difficulty can arise because we may not know all the facts, there are lots of pros and cons to weigh against each other, getting it wrong has severe consequences or it has a strong emotional element. Yet we still need to make an informed decision, even if it is to continue with the status quo.

A decision matrix combines the elements of what makes a good decision – past experience, personal values, intuition, the scientific evidence, and risk. It helps focus on the critical factors, ignoring the 'noise' and provides a point when 'on balance' you make a different decision. Arguably it forces you to slow down your decision making, to pause, think and compare before choosing what to do.

The decision matrix approach has other benefits. It documents what you have considered in coming to a decision, making it available for others to follow. This can be particularly useful when explaining decisions to others - between generations, managers and workers or with advisors and banks.

The decision matrix approach is particularly good for recurring decision, as it can be refined over time as new knowledge and experience builds.

The suggested steps in building a decision matrix are outlined. It is important to recognise that it is OK to disagree with some of the content in the examples provided. You may want to include different critical factors and disregard others. You may want to change the relative values or you may wish to change the 'tipping point' value where different decisions are suggested.

All of this is legitimate. *Ultimately you need to own the decisions you make and therefore the matrix needs to reflect your thinking!*

Creating a decision matrix takes time, especially if people are new to the process. It is important to work through the process with your advisor in a small group workshop setting and/or one-on-one until you are comfortable with the decision matrix. It is also important to review the matrix with your advisors after the decision has been made and action has been implemented to see if the matrix needs to be altered for future decisions.

Eight steps to create a decision matrix

1. **Identify the decision** you need to make. It could be something that occurs on a regular (annual) basis e.g. how much crop to sow or how much fodder should I conserve this year, or as once off decision e.g. should I buy this block of land?

   Tip 1 - Endeavour to make the description as clear as possible and avoid including more than one decision within the statement.

   Tip 2 – Binary (yes/no) responses are the easiest decision matrices to construct (see step 5).

   Tip 3 – Aim to write the decision description with the two possible responses included.

2. **List the critical factors (big considerations)** you believe should influence the decisions. Usually there are only 4 to 8 critical success factors.

   Tip 1 - If there are less than 4 critical factors you can do in your head and any more than about 8 won't be critical, they will be 'noise'.

3. Take each critical factor in turn and ask "at what point would I think a bit differently about my decision"? This will split each critical success factor into a minimum of two or possibly more **considerations or tipping points**.

   Tip 1 – describe the *most favourable* conditions that supports the first part of the decision. Then describe the *least favourable* condition that supports the first part of the decision. Once the top and bottom tipping points are established (the 'bookends'), ask if there are any in between considerations. Insert these if needed.

   Tip 2 – Complete the first critical factor before moving on to the next critical factor.

   Tip 3 – The tipping point descriptions can be objective (numbers or measures) or more subjective. The intent of the descriptions is so the user associates that description with wanting to do something different e.g. If it was like this...., then I would do .... Repeat for each critical success factor.

4. Once all critical success factors have considerations (tipping points) described, **assign values** to them.

   Tip 1- Assign ALL the LOWEST considerations as 0.

   Tip 2 – Add up the number of critical factors in step 2 and multiply by 2. This provides an indicative HIGHEST value that can be assigned and give a range to work within. e.g. if there are 5 critical values, the highest value to be assigned would be 10 (5 x 2 = 10). You can choose another method but ensure there is a sufficient range of values to work with.

   Tip 3 - Assign the highest value to the critical factor and most favourable description that you believe is the most important for this decision. There may be several equally important critical factors.

   Tip 4 – Identify the next most important critical factor (and most favourable description) and give this a value *relative to the other highest considerations*. i.e. if you decide the highest consideration in critical success factor 1 should be twice as influential in the decision as the highest condition in critical success factor 2, then the first needs twice the value of the second. Repeat this for each critical value in turn.

   Tip 5 - Once the top and bottom values are established for all the critical factors, it is relatively easy to assign values to the remaining intermediate considerations.

   Tip 6 – This can become a drawn out process, so encourage people to go with their gut feel. The values can be adjusted later on.

5. Generate the **maximum score** by adding up the highest values assigned to each critical factor.

6. **Describe the decisions** you could make.

   Tip 1 – This can be taken from the decision in step (if it is concise enough). If not that obvious then read out all the most favourable conditions and then ask “what decision would I make?” Repeat for all the least favourable conditions (which will have a score of 0). These become the ‘bookends’ for your decisions and provide an answer for step 1.

   Tip 2 – You may wish to add further decision points in between these two ‘bookends’ but this can become confusing. If there are multiple decision points emerging, then maybe two matrices are needed.

7. **Assign threshold score(s)** to the decision. This incorporates the risk appetite of the individual. While there is no exact science behind what this score should be, a useful guide is to multiple the maximum score by the following risk tolerance. i.e. if the maximum score was 20, then the threshold score would be 14 (20 x 0.7 = 14).

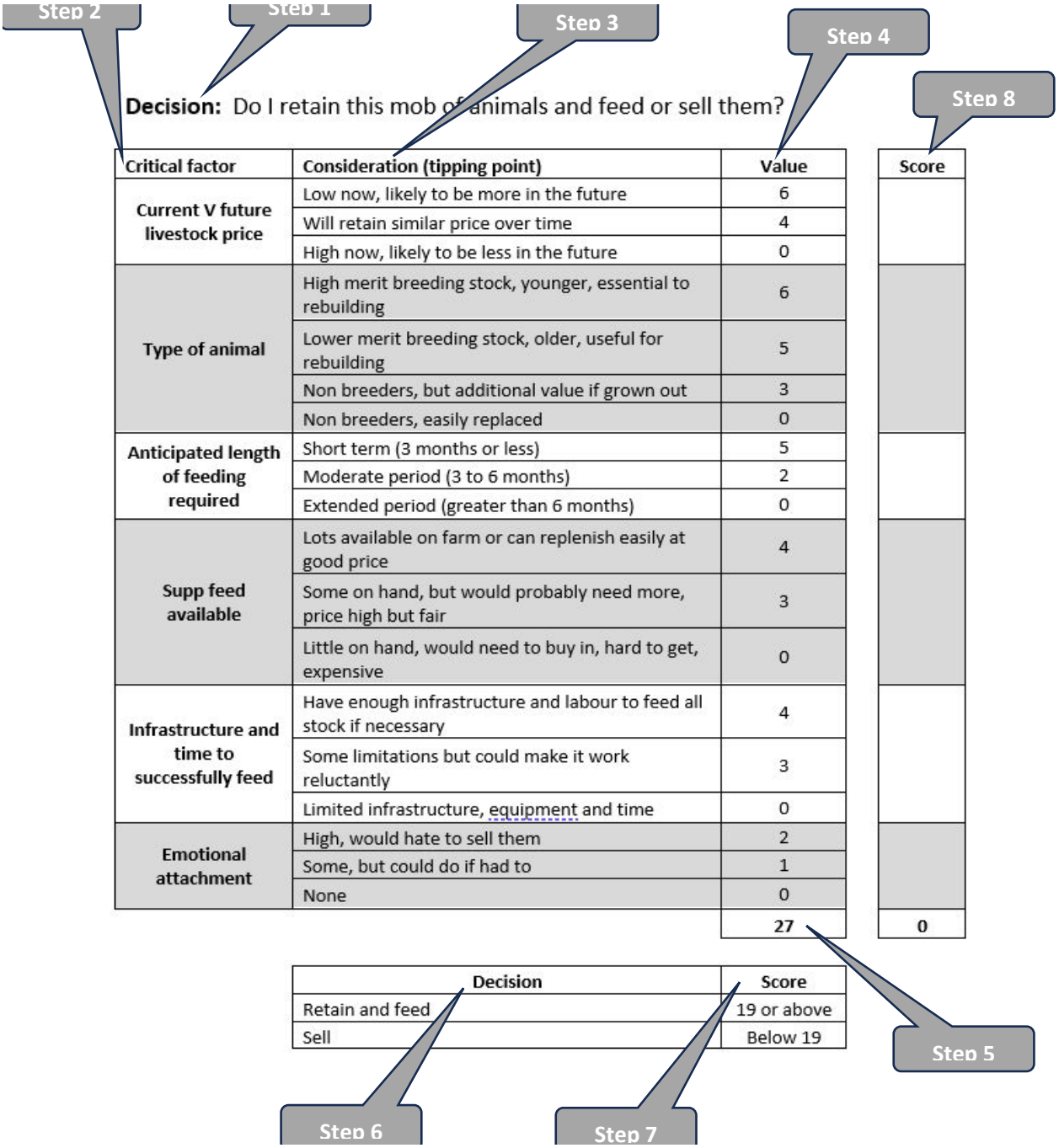
Risk tolerance	**2 decision points**	**3 decision points**	
	Multiply max score by		
Moderate	0.70	0.75	0.65

   Tip 1 – If a person has a higher or lower risk tolerance, then the threshold score will be higher or lower (depending on how the risk is inferred in the decision). This is best accommodated when scenario testing (step 8) is completed.

8. Test the matrix with a series of different **scenarios**. The aim is to test if the matrix gives plausible direction under a range of different circumstances. If it doesn’t then it could be because:
   a. The threshold score is too high or low (step 7)
   b. The assigned values are too high or low (step 4)
   c. Some critical factors are missing (step 2)

   Tip 1 - Think of a historic example where you know the outcome and can form an opinion if it was the ‘right’ decision. Answer each of the critical factors (as best you can remember) and see if the score points to what in hindsight was the ‘right’ decision for that person.

   A schematic of the location of the 8 steps on a decision matrix is provided (Figure 4).

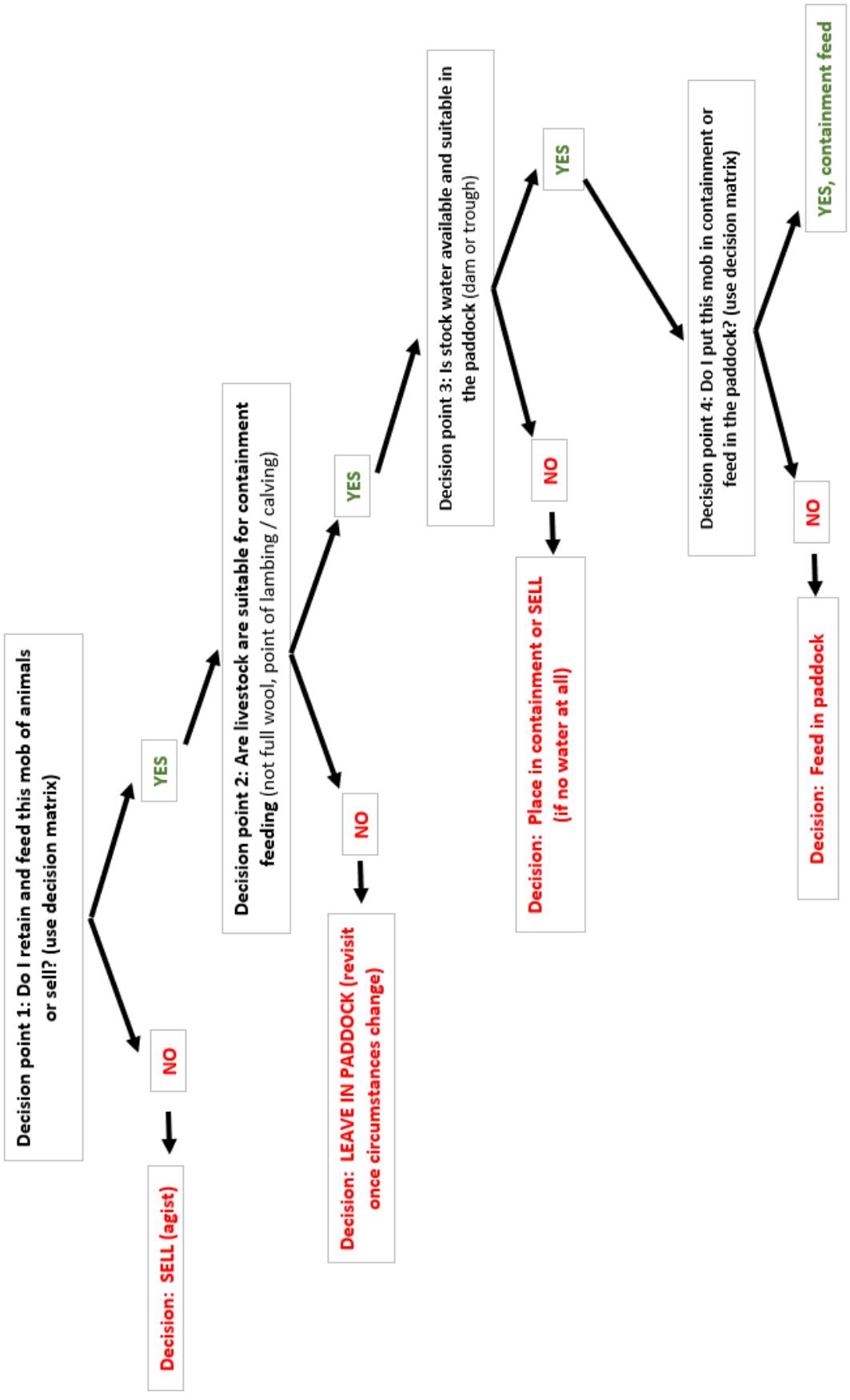


Critical factor	Consideration (tipping point)	Value	Score
Current V future livestock price	Low now, likely to be more in the future	6	
	Will retain similar price over time	4	
	High now, likely to be less in the future	0	
Type of animal	High merit breeding stock, younger, essential to rebuilding	6	
	Lower merit breeding stock, older, useful for rebuilding	5	
	Non breeders, but additional value if grown out	3	
	Non breeders, easily replaced	0	
Anticipated length of feeding required	Short term (3 months or less)	5	
	Moderate period (3 to 6 months)	2	
	Extended period (greater than 6 months)	0	
Supp feed available	Lots available on farm or can replenish easily at good price	4	
	Some on hand, but would probably need more, price high but fair	3	
	Little on hand, would need to buy in, hard to get, expensive	0	
Infrastructure and time to successfully feed	Have enough infrastructure and labour to feed all stock if necessary	4	
	Some limitations but could make it work reluctantly	3	
	Limited infrastructure, equipment and time	0	
Emotional attachment	High, would hate to sell them	2	
	Some, but could do if had to	1	
	None	0	
		27	0

Decision	Score
Retain and feed	19 or above
Sell	Below 19

FIGURE 61: 8 steps on a decision matrix.

APPENDIX 2: Flowchart to decide if animals should be placed in containment



APPENDIX 3: Useful resources to help determine the appropriate values in the example decision matrices

Decision: Do I retain this mob of animals and feed or sell them?		
Critical factor		**Useful resources**
Current V future livestock price	Historic commodity prices	https://agprice.sfs.org.au/
	Future commodity prices	https://mecardo.com.au/category/insights/
Type of animal	**User assessment required**	
Anticipated length of feeding required	Rainfall forecasts	https://agriculture.vic.gov.au/support-and-resources/newsletters/the-break/the-fast-break-victoria
	Location specific 30, 60 90 day rainfall	https://myfarmdashboard.sfs.org.au
	Climate outlooks	http://www.bom.gov.au/climate/outlooks/#/overview/summary
Supp feed available	**User assessment required**	
Infrastructure and time to successfully feed	**User assessment required**	
Emotional attachment	**User assessment required**	

Decision: Do I put this mob into containment or leave in paddock and feed?		
Critical factor		**Useful resources**
Feed available in the paddock	Dry matter assessment (how much feed do we have across the farm pdf)	https://sfs.org.au/tool/simple-summer-feed-budget
	Australian feedbase monitor - free satellite imagery	https://www.mla.com.au/extension-training-and-tools/tools-calculators/australian-feedbase-monitor/
	Feed on offer library - Visual images	https://www.feedonofferlibrary.com/search/
Groundcover (soil protection)	Groundcover assessment pdf	https://sfs.org.au/tool/simple-summer-feed-budget
	Australian feedbase monitor - free satellite imagery	https://www.mla.com.au/extension-training-and-tools/tools-calculators/australian-feedbase-monitor/
Quality of pasture	Feedtest services	https://www.foragelabaustralia.com.au/
		https://feedtest.com.au/index.php/services
	Feed on offer library - Visual images	https://www.feedonofferlibrary.com/search/
Containment facility (infrastructure)	**User assessment required**	
Labour efficiency in feeding	**User assessment required**	
Seasonal forecast	Rainfall forecasts	https://agriculture.vic.gov.au/support-and-resources/newsletters/the-break/the-fast-break-victoria
	Location specific 30, 60 90 day rainfall	https://myfarmdashboard.sfs.org.au
	Climate outlooks	http://www.bom.gov.au/climate/outlooks/#/overview/summary

Australian Government

Department of Agriculture, Fisheries and Forestry

Future Drought Fund

SA DROUGHT HUB

This program received funding from the Australian Government's Future Drought Fund