



Department of
Primary Industries

Managing drought

NINTH EDITION



www.droughthub.nsw.gov.au

Managing drought

NINTH EDITION

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Contents

iv Acknowledgments

1 Foreword

2 Section 1 Drought in NSW

- 2 NSW's drought policy
- 2 Combined Drought Indicator (CDI) explained

6 Section 2 Planning for drought

- 7 Drought planning
- 11 Drought strategies for the livestock producer
- 15 Drought action plan

17 Section 3 Feeding livestock

- 17 Dangers in feeding waste material to livestock
- 20 Supplementary feeding of cattle
- 24 Managing full hand feeding of beef cattle
- 29 Full hand feeding of beef cattle – quantities
- 34 The value of unusual feeds in drought
- 36 Managing dairy cattle
- 37 Full hand feeding of sheep – management
- 41 Full hand feeding of sheep – quantities
- 46 Full hand feeding of sheep – feeding management
- 47 Water requirements for sheep and cattle

51 Section 4 Farm management

- 51 NSW DroughtHub
- 51 Personal and family wellbeing and financial assistance guide
- 52 NSW DPI Rural Resilience Program
- 56 Pasture sustainability and management in drought

74 Section 5 Appendices

- 74 Appendix 1
- 76 Appendix 2
- 77 Appendix 3



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Foreword

This new edition of the NSW Managing Drought Guide has been prepared to give NSW primary producers relevant information to help them make informed decisions on how to effectively manage the impacts of the current drought, as well as future extended dry spells.

The challenge of managing drought has been something generations of farmers have had to face, but we know the impacts of drought reach well beyond the farm gate.

This guide reflects the unique pressures placed on NSW producers before, during and after drought and includes strategies and actions that farmers can consider as they deal with its effects on their businesses.

It also includes information on relevant resources from the NSW Department of Primary Industries (DPI) and Local Land Services, practical information on feeding livestock, farm management and sustainable practices, as well as personal and financial well being.

For more information on the NSW Government's broad range of support and assistance measures to support our farmers, their families and regional communities impacted by drought conditions, I encourage you to visit www.droughthub.nsw.gov.au, which is a central source of information on the government's drought assistance measures.

The DPI's Combined Drought Indicator is also available on the DroughtHub website and provides the most detailed conditions information available for NSW primary producers.

The NSW Government will continue to stand with our farmers and communities during these difficult times, ensuring the right support and assistance is available and that they are poised to take every opportunity when better conditions prevail.

Hon. Adam Marshall MP

Minister for Agriculture

Minister for Western New South Wales



Section 1 Drought in NSW

NSW's drought policy

The NSW Drought Strategy supports primary producers to become more resilient and better prepared for adverse conditions and drought. The strategy provides assistance including finance, skills and training, animal welfare assistance, information, research and development, and social support.

Combined Drought Indicator (CDI) explained

How does it work?

Much of the information in the Seasonal Conditions Report is sourced from the NSW DPI Enhanced Drought Information System (EDIS)[™]. The EDIS system was launched in early 2018. For more information, visit the interactive website via DroughtHub.

EDIS is an ongoing project aimed at improving the quality and timeliness of seasonal conditions information across the state. Key features of the system are:

It tracks drought by using four indicators; rainfall, soil water, plant growth, as well as tracing rainfall trends.

The Combined Drought Indicator (CDI) brings this information together, and has been designed to characterise developing drought conditions. The key purpose for building the CDI was as a drought early warning system.

The rainfall, soil moisture and plant growth indicators in EDIS account for conditions over a 12 month window. This provides a compromise between a highly sensitive indicator (e.g. six months) and a less sensitive indicator (e.g. 24 months).

Climate and remote sensing data drive the information system at a high resolution, but the CDI is reported at a Parish level.

Because of its configuration and purpose, there will be differences to the indicator used in the National Drought Monitoring Framework (the Australian Rainfall Deficiency Analyser) which relies on rainfall alone.

The CDI has three drought categories that characterise NSW according to drought intensity as well as the main drivers of a drought event (meteorological, hydrological and agronomic). DPI considers areas categorised as Drought Affected to be experiencing a drought event.

The Drought Affected category encompasses a wide range of conditions from the very early stages of drought entry through to a drought event becoming intense. This enables the drought monitoring system to detect a drought event early. It is also possible to stay in the Drought Affected category for some period of time.

More services from EDIS have been released more recently including a NSW DPI Farm Tracker: an app that allows you to self-report conditions on your farm.

The way in which the indicators are combined to form the CDI is described in Table 1 below.

Table 1. Description of the Combined Drought Indicator framework

CDI Phase	Technical definition	Description – typical field conditions
Intense Drought	All three indicators (rainfall, soil water, plant growth) are below the 5th percentile	Ground cover is very low, soil moisture stores are exhausted and rainfall has been minimal over the past 6–12 months.
Drought	At least one indicator is below the 5th percentile	Conditions may be very dry, or agronomic production is tight (low soil moisture or plant growth). It is possible to be in Drought when there has been some modest growth, or a few falls of rain.
Drought Affected (intensifying)	At least one indicator is below the 30th percentile and the rainfall trend is negative over the past 90 days.	Conditions are deteriorating; production is beginning to get tighter. Ground cover may be modest, but growth is moderate to low for the time of year. When indicators are close to the Drought threshold drought conditions are severe.
Drought Affected (weakening)	At least one indicator is below the 30th percentile and the rainfall trend is positive over the past 90 days.	Production conditions are getting tighter, but there have been some falls of rain over the past month. It is rare to enter the Recovering phase from the Non-Drought category; Usually there is a quick (1–2 week) transition into Drought Affected or Drought. When indicators are close to the Drought threshold drought conditions are severe.
Recovering	All indicators are below the 50th percentile but above the 30th percentile	Production is occurring but would be considered 'below average'. Full production recovery may not have occurred if this area has experienced drought conditions over the past six months.
Non-drought	At least one indicator is above the 50th percentile.	Production is not limited by climatic conditions.

Report conditions on your farm

Do you want to get involved and report conditions on your farm?

The NSW DPI Farm Tracker app allows you to take stock of conditions at your place. The app allows you to record rainfall, pasture availability, livestock conditions, crop performance and other on farm conditions.

This allows you to keep a record of your farm over time, or use the information to compare different areas of your farm. If updated regularly, this information is a valuable record of how seasonal conditions affect your property.

The information you collect will also contribute to the Government's seasonal conditions monitoring. The data from your reports provides a valuable ground truth of the information in NSW DPI's seasonal conditions monitoring systems.

Over time your data will also help improve the accuracy of early warning for all farmers across NSW. This is particularly valuable in areas where there are few rain gauges.

www.droughthub.nsw.gov.au

NSW Drought Monitoring

Combined Drought Indicator - Explained

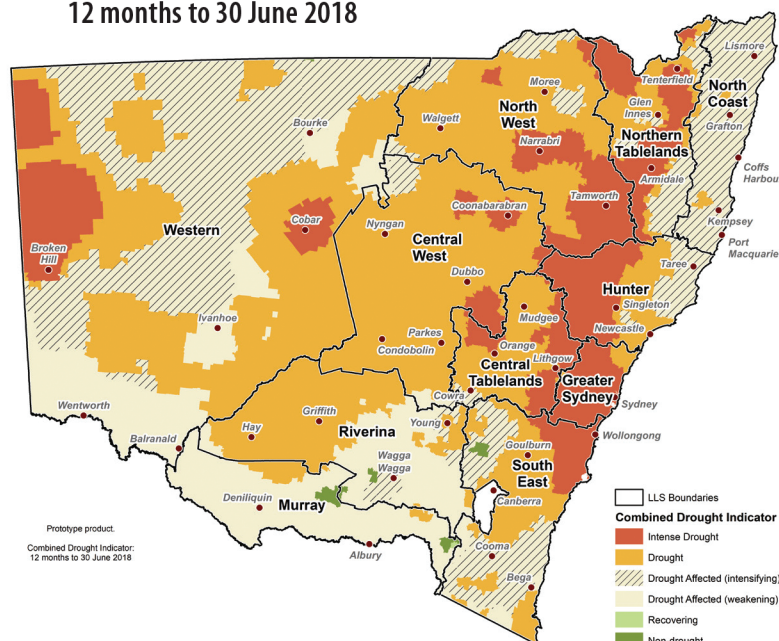
Overview

- The Combined Drought Indicator (CDI) is the first stage of NSW DPIs Enhanced Drought Information System™ program, which aims to continually improve the detection monitoring and forecasting of drought for farmers in NSW.
- The CDI monitors current seasonal conditions using indicators of rainfall, soil water and plant growth. The indicators are expressed as a percentile* by ranking current seasonal conditions for any given location against a long-term baseline of historical conditions for that location.

Key Features

- Detects drought entry early, as **Drought Affected**.
- Tracks drought recovery as **Drought Affected**.
- Monitors different event intensities as **Drought** and **Intense Drought**.
- Drought duration is the combined time spent in the **Drought Affected**, **Drought** and **Intense Drought** categories.

Combined Drought Indicator 12 months to 30 June 2018



* For example, the 10th percentile of rainfall indicates that current rainfall is within the lowest 10% of historical value. Using percentiles in this way allows for comparisons to be made about the severity of current conditions across locations that otherwise may be very different in terms of rainfall and soils.

Categories Explained

Intense Drought

Definition: All three indicators below the 5th percentile.

Typical conditions: Stock water critical, ground cover minimal, event is prolonged.

Drought

Definition: One indicator is below the 5th percentile.

Typical conditions: Stock water in decline, ground cover is minimal.

Drought Affected

Definition: One indicator is below the 30th percentile.

- Intensifying when 90 days rainfall trend is negative.
- Weakening when 90 days rainfall trend is positive.

Typical conditions: Pasture growth is low, decision to destock or hand feed as indicators intensify.

Recovering

Definition: All indicators are below the 50th percentile but above the 30th.

Typical conditions: Production is occurring but would be considered 'below average'.

Non Drought

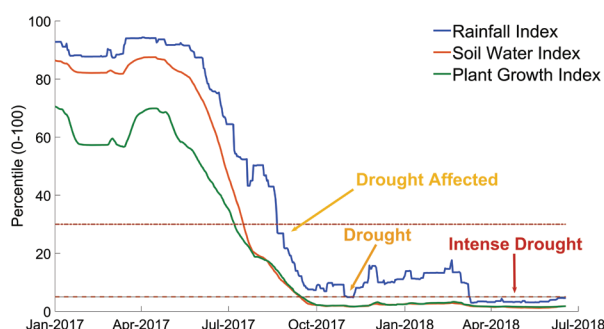
Definition: At least one indicator is above the 50th percentile.

Typical conditions: Production is not limited by climatic conditions.

Tracking Drought Categories

The Combined Drought Indicator is an interactive tool that allows farmers to navigate to any parish in NSW to see which seasonal conditions phase that area is experiencing.

The below is an example of the three indicators tracking drought in the parish of Molong in the Cabonne local government area.



NSWDPI Farm Tracker™



A Guide for Farmers

Background

Farm Tracker is an important part of the Enhanced Drought Information System, an ongoing program of work to improve the State's drought monitoring.

Purpose of the App

Farm Tracker is a tool you can use to record seasonal conditions. You can:

- Complete a simple crop, pasture or animal survey
- Keep and manage a photo diary of your farm
- Monitor the same paddock over many years

Farm Tracker takes the hassle out of record keeping. Simply complete the questions that are most relevant and leave the rest blank. Reports can be completed in a matter of minutes and they are synchronised with your personal database as well as the state wide database as soon as you are in mobile or wi-fi range.

How will your data be used?

Aside from your own use, reports collected by Farm Tracker provide a highly valuable source of ground truth information for DPI's Drought Mapping Services. Each month, reports will be used to verify the maps for the official State Seasonal Update.

Using the App

Loading the App

- Search for NSWDPI Farm Tracker and download the app from the App Store
- Set up a new account (password must contain upper and lower case characters, a numeric value and special character i.e. #)\$)
- Allow the app to access your camera and location data

Recording your seasonal conditions

- Click on New Report to start
- Click on the camera icon to take a photo. If you are in mobile reception, the image will be automatically geotagged to record your location, or you can select your location using the marker icon
- Scroll through the questions and only fill in those that are relevant
- Use the info icon for help
- Save report and use the History tab to see all of the reports you have made

Manage your records online

- Use the website www.farmtracker.nsw.gov.au to view your reports online
- Just log in to your unique user account using the same email and password you used for the app to get started
- Option to download your data into a csv file

Download
NSWDPI Farm
Tracker™

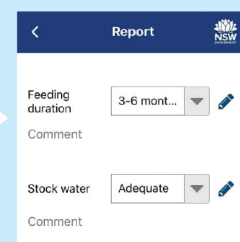


Take a Photo
to get started



Image taken near Young
19 June 2018

Record your
Seasonal
conditions



Easy to use drop down boxes to
record conditions on your farm

Find NSWDPI Farm
Tracker™ in the App Store

Section 2 Planning for drought

- » Drought planning
- » Drought strategies for the livestock producer
- » Drought action plan

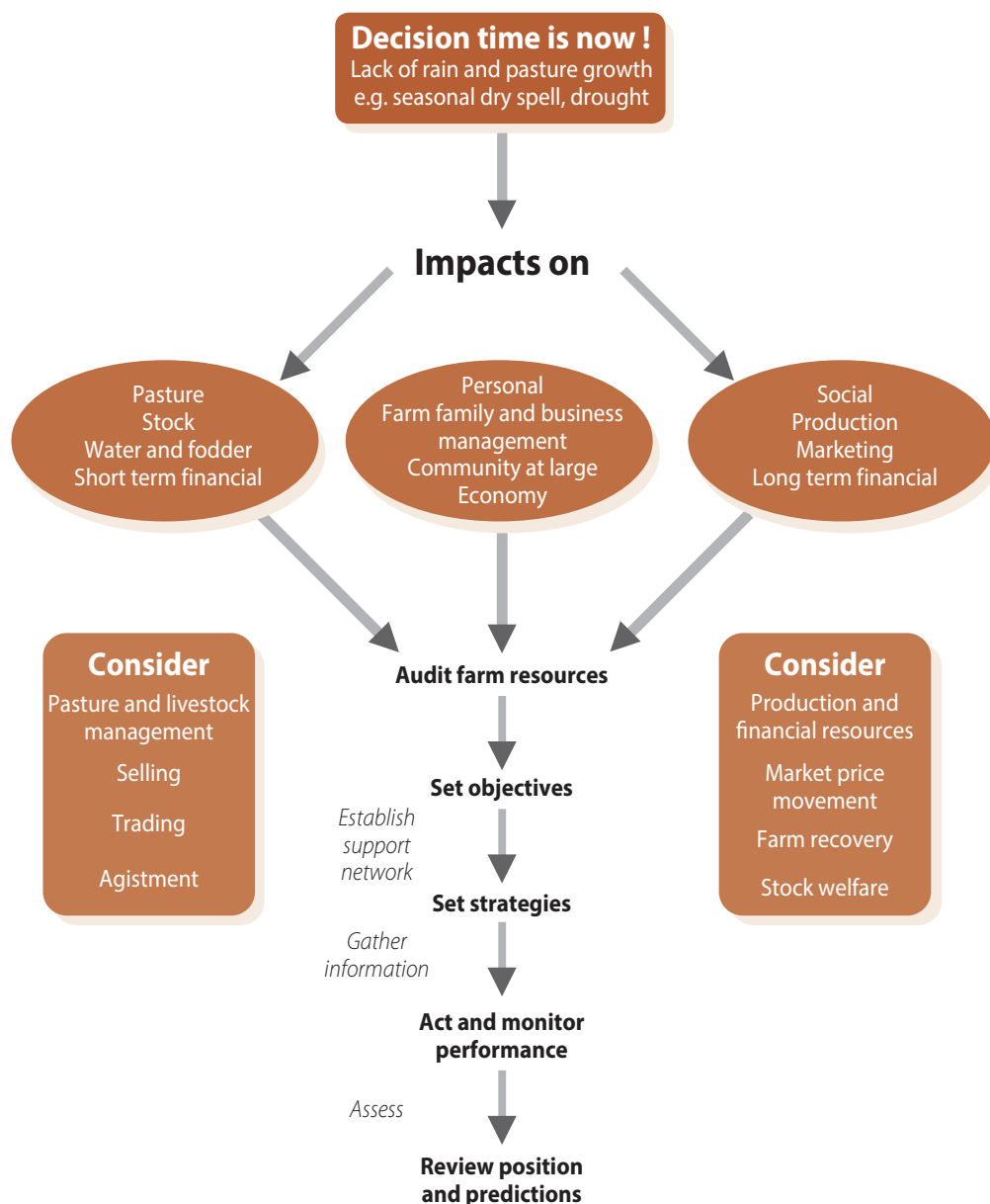


Figure 1.

Drought planning

In drought management, a positive approach to the problem, a clear understanding of your objectives and a careful evaluation of alternative courses of action are essential for success. You should be realistic in your assessment of the situation and not underestimate the resources (capital, fodder and management) and personal and family cost to implement a particular course of action.

In drought it is important to have a plan, act early, review and then plan again, revising the plan as each step is implemented.

Where to start?

Step one: Check the most limiting farm resources:

- » mental and physical energy to do the continuous tasks required
- » funds available
- » stock and domestic water available
- » feed reserves (paddock and stored) available
- » surface/subsoil moisture for crop leaf and root growth
- » available livestock fat reserves stored enabling controlled weight loss
- » need to service machinery – breakdowns cost time, money and frustration.

Audit sheets are provided on the following pages to guide you through the resource audit.

Step two: Set action strategies considering:

- » breakeven position of each strategy chosen
- » windows of opportunity to adopt management practices that will be profitable during drought
- » your available resources and the implications for animal welfare, ground cover, chemical residues etc of carrying out each strategy
- » when situations are changing, conditional and timely fallback options.

Step three: Monitor and review performance position and outlook by:

- » using your established network to stay informed about key factors that affect your drought strategies
- » being proactive about the decisions made
- » being prepared for change
- » remembering that the impact falls very heavily not only on the decision makers but also on the whole farm family.

To make good decisions during a drought it is necessary to assemble as much information as you can on the factors that will influence your decisions. Information on 'what to do?' comes from:

- » past dry spells and drought experiences
- » your established rural network
- » past trends and current predictions
- » decision support tools to inform potential strategies.

What livestock do you have on hand?

Table 2.

Class of stock	Fat scores	Now	Can sell	Keep and feed
1st calf heifers				
Cows with calves				
Dry cows				
Bulls				
Weaner/yearling heifers				
Weaner/yearling steers				
1–2 year old steers				
TOTALS				
Maiden ewes with lambs				
Mature ewes with lambs				
Dry ewes				
Weaned lamb				
Hoggets				
Wethers				
Rams				
TOTALS				

What feed do you have on hand?

Table 3.

Feed	Quantity
Paddock feed – describe your pasture situation. I estimate that on average my paddocks have _____ kg DM/ha available for grazing.	

Stock water supplies

See *Primefact 269 Stocktaking water supply for livestock* to help you estimate your useable stock water supplies.

Table 4.

Estimated total useable Water	ML (A)
Stock water requirement per day for current stock	ML/day (B)
Sufficient water to supply my stock for (A ÷ B)	Days
What are your priority groups of livestock to:	
Sell	
Feed	

Stock sales

If there is no paddock feed/rain for six months what are your choices?

Table 5.

Sell calves	All
	Some
Wean calves & feed	Early calves
	Late calves
Sell cows	All
	Some
Sell bulls	All
	Some
Sell wethers	All
	Some
Sell ewes	All
	Some
Sell lambs	All
	Some

What income can your sale stock bring?

Table 6.

Stock type	Number of stock	Estimated sale price	Total
1st calf heifers			=
Cows			=
Bulls			=
Weaner/yearling heifers			=
Weaner/yearling steers			=
1–2 year old steers			=
Maiden ewes with lambs			=
Mature ewes with lambs			=
Dry ewes			=
Weaned lambs			=
Hoggets			=
Wethers/rams			=
		Total	

Discuss your drought management options with your accountant to ensure that the Australian Tax Office classifies your business as 'Drought Declared'. This allows for example, income from forced sales to be deferred to subsequent years. It also allows amounts for emergency relief, such as food and personal clothing, to not be classed as income and hence won't be taxed.

What evidence can you provide?

Table 7.

Photos	Y/N
Livestock sale records	Y/N
LLS advice	Y/N
NSW DPI advice	Y/N
Rainfall records	Y/N
Do you plan to feed?	
What will you feed?	

How much do you need to feed each animal to achieve your goals?

See Section 3 of this handbook for details on calculating feed requirements: Full hand feeding of beef cattle – quantities and full hand feeding of sheep – quantities.

Alternatively use the Feed cost calculator on the NSW DPI website
www.dpi.nsw.gov.au/feed-cost-calculator

Table 8.

Kg feed/day/head =	
x Number of head (.....) =	(a)
Cost/kg feed =	(b)
Total feed cost per day (a) x (b) =	\$
How long are you prepared to feed – until which month?	
How many months will that be from now?	
Will you feed cows, to get them back in calf?	Y/N
Will you feed ewes, to get them back in lamb?	Y/N
Are you using a 'sacrifice paddock' to feed stock now?	Y/N

Finances

Table 9.

How much money are you able to spend on drought feeding?	\$
How much will it cost you to feed the stock you plan to keep for the months you plan to feed?	\$

The degree of planning depends on your level of risk and how you assess your past, current and future climate, pastures, livestock and business situations.

A whole-farm plan approach is required. Targeted action strategies can be implemented, including fallback options, forward contracts, etc. to ensure that the farm business and its goals are achieved.

Computer decision support programs such as the NSW DPI Drought Feed Calculator App, Grazfeed, CliMate and StockPlan can help producers, professionals and industry to plan ahead.

StockPlan (see Appendix 3) online learning tools can help cattle and sheep producers to explore management options in the early stages of drought and during drought. These tools help producers to make management decisions that minimise the environmental and financial impacts of drought.

Drought strategies for the livestock producer

The objective of your drought strategies, which always takes into account the welfare of stock, should be to ensure that the farm business survives and that the productive resources of the farm – the soil, the capital, and the genetic merit of the livestock – are managed to allow production to recommence after the drought.

Objectives should be clearly defined both for the drought period and for the post-drought (recovery) period. Recovery from a significant drought may take several years, particularly if debt levels rise substantially or if pastures are depleted and require re-sowing.

Your objectives should be clear and, wherever possible, be stated in numbers, dates or dollars.

Write down your objectives and review them regularly. Your objectives can be changed as the situation dictates. It is important that your objectives are not 'set in concrete' – they are a guideline, not a boundary, and if the situation requires that you change them, provided you have examined the options thoroughly, then they have served their purpose and can be replaced.

If you don't review and change your strategies there is a chance that recovery after the drought may be impossible. In this situation you may have to make a trade-off between short-term and long-term objectives. You may choose to incur greater costs during the drought to reduce your costs or increase your enterprise's chances of survival during the post-drought recovery stage.

Developing your strategies

Once you have clarified your objectives, you can then select various strategies and determine how each would contribute to meeting these objectives. To do this properly, you need to cost these strategies for droughts of various lengths; that is, you need to develop a 'model' of the drought so that you can estimate the effectiveness of various strategies over time. You will find that as the assumed period of drought varies, so does the likely cost of the different strategies. Similarly, varying the assumptions about the cost of restocking, or the current sale value of stock, dramatically affects the cost of various strategies.

No single strategy will be sufficient in most cases, and each situation will require a unique set of strategies according to the physical, financial and managerial resources available to the individual producer.

The six most common strategies are discussed on page 12. It is up to you to choose which options to employ, to what degree, and under what circumstances.

Tax treatment of forced livestock sales due to pasture and fodder loss

The five years following a forced livestock sale

If you are obliged to sell livestock because of the destruction of pastures or fodder through fire, drought or flood, you can elect to spread over five years the profit on the livestock sale. This means that one-fifth of the profit would be included in your gross income for the year of the sale of the livestock, and one-fifth would be included in the gross income for each of the following four years. To take advantage of this concession, you are required to declare that the sale was genuinely occasioned by the loss or destruction of pastures or fodder because of fire, drought or flood. In addition, you must demonstrate that the main part of the proceeds of the sale will be used to purchase replacement livestock or will be used in the maintenance of breeding stock for the purpose of restocking.

Alternatively, you may elect to have the profit on a forced livestock sale excluded from your assessable income for the year in which it was derived, and applied to reduce the cost of stock acquired during that year (or any of the five years after the sale) to replace the stock disposed of. Where replacement stock are bred instead of purchased, you may elect to include in your assessable income, over the same period, appropriate instalments of the profit on the forced sale (as described above).

If, at the end of the fifth year from the year in which the forced sale occurred, any part of the profit on the disposal has not been applied in reducing the cost of new stock purchased, or has not otherwise been included in assessable income, the amount that has not been applied will be included in your assessable income for that fifth year.

The six most common strategies

1. Selling stock

The timing of selling and the condition of stock at sale are critical.

Selective reduction of stock numbers early in a drought is nearly always an attractive proposition, especially with cattle. If stock are sold early in the drought, prices are likely to be better because the stock should be in reasonable condition and the market more likely to be firm. Selling stock also avoids feeding costs.

The question of which stock to sell involves knowing which are easier to handle during drought and which will be most productive or give the best returns after the drought.

Sheep, for example, have consistently given a higher percentage return to livestock capital invested than cattle. The longer the drought lasts, the more effective this strategy will be.

If the drought is short and a small number of stock have been sold, the remaining stock will probably compensate through increased performance per animal as a result of reduced stocking rate. It may not be necessary to repurchase stock.

With a longer drought and a higher number of stock sold, it is preferable to purchase restocker animals at reasonable prices when conditions improve. Livestock prices in the post-drought phase do not always rise dramatically because the financial reserves of graziers are depleted.

Early sale of stock will also generate cash to bolster the farm's equity position or generate interest, which will help longer-term business survival.

This should almost always be the first measure taken in the early period of drought. As the drought progresses, stock should be sold class by class, including finished young stock, aged stock, castrated stock, replacement stock, until a nucleus of young, sound, breeding females is left. This class of stock is likely to be the most valuable and capable of the best production when the drought breaks .

2. Production feeding

Production feeding includes maintaining a level of production either by ensuring turn-off of finished stock at a time when quality slaughter stock are at a premium, or by maintaining the breeding flock/herd in the hope that conditions will improve to allow progeny to be finished normally.

Option A – farm lot feeding

Farm lot feeding is an attractive option if there is a large gap between the price of store animals and that of finished animals, and the cost of ration ingredients is reasonable. It is important to take into account animal breed, nutrition requirements, marketing, ration costs and any infrastructure requirements when considering this option. Refer to *Primefact 554 Confinement feeding stock*.

Option B – maintaining performance of the breeding unit

Maintaining performance of the breeding unit assumes a short-term drought period and a market demand for the offspring in the future. It is more common in the cattle industry because the longer gestation period for cattle gives a greater chance of encountering a break in the drought than is the case for sheep.

Note that the production feeding of breeding females is costly and choosing this option when markets and seasonal conditions are erratic carries considerable risk.

3. Maintenance feeding

Maintenance feeding is widely practiced especially with sheep because the wool they will grow generates income to help offset costs.

Decisions to feed are often based on the availability of fodder stored on the farm and cash reserves, rather than on a rational examination of costs and returns.

In a short drought, maintenance feeding is likely to be a low-cost strategy. However, if the drought is prolonged, maintenance feeding can be very expensive, particularly if continued to the point where resources are exhausted.

Before commencing feeding, stock numbers should be reduced as discussed earlier,. Also, fat animals should be allowed to use some of their own body reserves before feeding commences. This reduces the feeding period and ensures the most efficient use of the feed.

4. Agistment

Agistment is widely used in regional droughts and is more widely practised with cattle than with sheep.

A written agreement is useful in formalising the duration, agistment costs, supplementary feed costs and other aspects of the arrangement. Before dispatching your stock, it is important to understand the quality and quantity of feed available, management facilities available (eg yards) and the relevant residue, pest and disease status of the agisted property (particularly concerning organochlorines, along with ovine/ bovine johnes disease and footrot).

Note that it is a legal requirement for sheep, cattle and goat owners to record livestock movements to and from agisted properties on the National Livestock Identification System (NLIS) database.

5. Trading in livestock

Many producers don't consider trading in livestock because of the loss of the genetic base built up over many years of a breeding program, and the risk of introducing disease. However, the market for livestock during a drought can fluctuate widely, and the opportunity often exists to buy a class of stock that is cheaper than another.

It may be possible to retain the same number of stock in terms of dry sheep equivalents and have much less capital tied up in livestock. The cash generated could be used to pay for feeding costs.

6. Humane destruction

Humane destruction of livestock is sometimes necessary in times of very low livestock prices and when animals are not fit to be transported.

It is not acceptable to allow domestic animals to starve to death or die of thirst. Under the Prevention of Cruelty to Animals Act, penalties can be imposed on a person who fails to provide an animal with appropriate and sufficient food and drink.

Humane destruction of an animal should be carried out to prevent suffering and distress, when it is cruel to keep an animal alive or when an animal is considered to be unfit to load or transport. Humane destruction should only be carried out by skilled persons using appropriate methods. In making this assessment, producers need to consider both animal and non-animal indicators that can affect survival. Animal indicators include emaciated body condition, depression, loss of appetite, inability to rise, and the presence of disease. Non-animal indicators include the availability of feed and water and extremely hot or cold weather.

In some situations it may be preferable to humanely destroy groups of animals before this 'point of no return'. Decreasing competition for feed will help the remaining animals to stay in better condition and be more productive after the drought. It will also reduce feeding costs. In making the decision as to which groups of animals need to be humanely destroyed, the producer should consider the genetics that are required after the drought and also the underlying vulnerability of different classes of animals.

Note that aged and unweaned animals and pregnant and lactating animals are more likely to be 'drought affected'.

In some situations it may be advisable to remove all stock from the property, for example if sheep are infected with footrot. If animals with similar or better breeding are likely to be available after the drought, then all animals could be either sold for processing or humanely destroyed.

For information on the humane destruction of livestock (and stock other than cattle and sheep) contact the District Veterinarian at your Local Land Services. People who experience distress associated with the humane destruction of livestock are advised to contact their local health services or the NSW Government's Rural Resilience Program.

For more information on whether animals are fit to load onto a truck, please visit www.dpi.nsw.gov.au/livestocktransport and download MLA's 'Is It fit to load guide'.

For more detailed information on the humane destruction of stock download the *Primefact 310 Humane destruction of livestock* fact sheet at www.dpi.nsw.gov.au/stock-destruction

Table 10. Advantages and disadvantages of the six most common strategies

Strategy	Advantages	Disadvantages
Selling some or all stock	» No cash outlay is required (unless values are minimal) » Interest on proceeds of sale can be earned » Good prices are more likely if stock are sold early » Risk of damage to pastures is reduced. Improved performance of remaining stock post-drought may compensate for reduced numbers » Reduces labour input – time is available to pursue other activities » Can select culls to improve flock genetics.	» Stock may need to be repurchased after drought (prices could be high) » Income declines due to lost production » Breeding cycle may be disrupted » Stock may have to be sold at a substantial discount if held for too long » Taxation may be affected » Genetic material is lost if culling does not discriminate
Production feeding	» Throughput of stock is maintained » Livestock inventory can be maintained at high levels by purchasing more stock for feeding, reducing restocking problems » Cash flow is maintained » Lot feeding protects pastures	» Costs are high, while market prices are uncertain » High labour input is required » Feeding costs increase for pregnant and lactating cows, and as growing animals put on weight
Maintenance feeding	» Income may be earned from production of progeny and/or wool » Restocking costs are avoided » Maintenance of breeding cycle may be possible	» Costs are directly related to length of drought » Large financial reserves may be required for practical periods High labour input is required Performance levels are affected » Young stock do not perform well
Agistment	» Agistment may be cheaper than maintenance feeding per unit of food provided, depending on transport costs and the duration of agistment » If good agistment is available, full production may continue » Damage to pastures is minimised » Breeding program can continue	» Drought may affect agistment property » Stock must adapt to new area » Stock thefts may occur » Handling facilities and managerial control may be inadequate » Weeds and diseases may be introduced when stock are returned to original property
Trading in livestock	» Cash flow is provided for feeding and running costs so that total livestock numbers can be maintained » Can allow enterprise shift	» Weeds, diseases etc. may be introduced » Breeding cycle may be disrupted » Genetic base is lost
Humane destruction	» Prevents unacceptable suffering » Reduces stocking rates, enhancing chances for the remaining stock » Helps reduce further pasture and land degradation » Reduces hand feeding costs » May reduce the impact of, or eliminate, a disease, e.g. footrot	» Financial loss of stock value » Costs of slaughter and disposal and unpleasant task » Some risk to operator » Loss of genetics can occur if there is no selection

Summary

Here are the recommended steps to preparing drought strategies:

- » start early in a dry period to establish your short-term and long-term objectives
- » assemble facts and figures on all aspects of alternative strategies: feed costs, rainfall records (official records and local experience), stock prices, agistment, support and subsidies
- » cost strategies for various lengths of drought
- » select the strategies that best fit your projections and situation
- » write down your objectives and strategies, and whenever possible, set down numbers, dates or dollar figures as benchmarks or triggers for particular actions
- » review your strategies continually and adapt them if necessary.

More information

More information is available at www.droughthub.nsw.gov.au and www.dpi.nsw.gov.au/animals-and-livestock

Drought action plan

Reminders

When a drought is in its early stages it is important to remember:

- » make decisions early and review them regularly
- » don't wait – set a timetable and keep to it as closely as possible
- » it is a common belief that livestock will be expensive and unprocurable at the end of a drought – this has not been the case after past major droughts
- » paddocks that have poor water should be grazed first
- » don't forget about the routine procedures for maintaining animal health, particularly drenching against worms
- » wean calves – feeding cows with calves is expensive
- » consider changing from hay to grain – cost hay against grain
- » pregnancy test – why feed non-productive animals?
- » fat score your stock
- » assess the dentition and structural soundness of your stock and cull accordingly.

Review the following advice early in a drought and use it to help you plan your strategies.

Plan your strategies early

Droughts develop progressively, not overnight. Plan your strategies in early drought to ensure the economic survival of your business.

Experience from previous droughts is a guide as to what can happen. While factors such as stock prices, feed costs, availability of feed, and interest rates will vary, the following points are typical of all droughts:

- » Drought decisions are often made on an emotional rather than a logical basis. Try to make objective decisions and seek skilled help when necessary.
- » One reason given for retaining livestock in early drought is that the stock on hand are thought to be of superior quality and that replacing them at reasonable cost would not be possible. Except for seedstock animals, this is rarely the case.
- » Not all aspects of drought are bad – it can lead to opportunities for making money from enterprises such as lot feeding, and this experience can be used to your advantage in normal seasons.
- » The producers who do best during droughts are those who adopt sound management and financial plans, review these regularly, make firm decisions, and act early and quickly.

Be on the alert for opportunities

Every drought is different so you should evaluate all possibilities. Be on the alert for opportunities such as:

- » buying or leasing land instead of buying feed
- » replacing old animals with younger ones
- » changing breeds or enterprise mix eg from weaners to feeder steer production.

A single trading decision at the right time could contribute more to your viability than a lengthy feeding program. Your ability to take advantage of opportunities depends on maintaining stock in saleable condition.

Act quickly to reduce risk

The higher the risk of a major crash in the market, the more important it is to take progressive action early. Dollars earned from selling culled animals while the market is still strong will give you greater flexibility if conditions deteriorate.

Factors affecting risk are the:

- » national population of livestock including feedlots
- » domestic and export market demand for beef/ sheepmeat
- » extent and severity of the drought-affected area
- » likelihood of rain and the potential to grow feed at various times of year
- » adequacy of regional, state and national feed supplies.

Assess your position

When assessing your position, think about the risk factors and ask yourself the following questions:

Stock

For each class of stock, monitor the:

- » Rate of weight loss?
- » On going feed requirements and costs?
- » What should be culled?

Finance

- » What are my stock worth on the market and what are the market prospects?
- » Are there other trading opportunities? For example, sell cows and buy yearlings or buy sheep?
- » What is it costing to feed my stock per head per month?
- » What can I afford to spend on maintaining my stock?
- » What are the taxation considerations?

Feed

- » What feed do I have? Is it suitable?
- » If I need to buy feed, what is the price and availability?
- » Is it worthwhile selling conserved fodder such as hay and buying another type of feed such as grain?
- » Will reserves be adequate to cover increased seasonal needs such as at calving or in winter?
- » Have I allowed for full drought feeding or only for supplementary feeding?
- » What are the prospects for agistment or leasing?

Review your progress regularly

The extra worry and stress caused by a drought, especially when you are preoccupied with feeding regimes, makes it hard to think logically about the big decisions. However, it is vital to take time to review what is happening, to monitor the changing situation for stock, feed or agistment, and to plan the next step in your drought management program.

You should review progress systematically and regularly, ideally once a month. Planning helps you to retain a feeling of control and anticipate each major crisis.

Sometimes it is beneficial to have someone help with your assessment. Your local LLS team can help you assess your options.

Develop skills for assessing pasture

It is a good idea to develop skills for assessing pasture quantity and quality. Good drought management relies on matching animal requirements with available pasture. Degradation of pasture leads to future income reduction and soil loss.

Make sound livestock decisions

In early drought you should:

- » reduce grazing pressure by selling, agisting, culling or lot feeding stock – this is the most effective way of staying viable and reducing costs if the drought continues
- » maintain a positive cash flow by selling some stock
- » keep your options open
- » concentrate your effort on the animals that have the potential to earn the most money – your enterprise is then more likely to stay productive.

Draw up a timetable with progressive deadlines for taking action, such as seeking agistment, selling stock, or starting to feed.

It is common to feed stock during dry spells and seasonal shortages of feed. However, full drought feeding can be expensive, laborious, depressing and frustrating. Make sure you evaluate and implement options that reduce or eliminate feeding wherever possible.

More information

www.dpi.nsw.gov.au/animals-and-livestock

Section 3 Feeding livestock

- » Dangers in feeding waste material to livestock
- » Chemical residue risks
- » Supplementary feeding of cattle
- » Full hand feeding of beef cattle – management
- » Full hand feeding of beef cattle – quantities
- » The value of unusual feeds in drought
- » Managing dairy cattle
- » Full hand feeding of sheep – management
- » Full hand feeding of sheep – quantities
- » Full hand feeding of sheep – feeding management
- » Water requirements for sheep and cattle

Dangers in feeding waste material to livestock

Using plant-processing wastes, reject fruit and vegetables and other food wastes as livestock feed may seem a practical and economic way of using or disposing of such materials.

However, people producing stock or animal products intended for human consumption should be aware that feeding any material that has not been produced specifically for use as stock feed can cause unacceptable chemical residues in animal products.

Quality control systems are essential to ensure that any materials fed to stock, and the final livestock products, meet stringent residue standards. Generally, there are no specific systems in place to prevent the occurrence of unacceptable chemical residues in these waste materials.

There are also legal restrictions on the materials that may be fed to certain livestock (eg meat and bone meal to ruminants) to prevent the development and/or spread of several serious animal diseases.

Chemical residue risks

Livestock producers are responsible for ensuring that the animals and products that they market do not contain unacceptable chemical residues.

The penalties for failing to manage these risks are significant:

- » Australian meat exports into overseas markets may be potentially banned
- » affected livestock are legally restricted from entering the domestic food chain, and
- » affected animal products can be condemned without payment to the producer.

Some chemicals concentrate in wastes, which increases the stock residue risks. Materials such as citrus pulp, fruit pomace, grape marc, and vegetable skins and outer leaves often have higher residues than the commodity from which they are derived.

Some chemicals registered for use on fibre crops and on fruit and vegetables are not registered for use on stock feeds or livestock. Consequently, there may be no maximum residue limits (MRLs) set for the chemical in animal products. If a chemical has no animal product MRLs then any detectable level of that chemical in these products breaches food standards.

As an added safeguard against unacceptable residues in animal products, label directions for some agricultural chemicals prohibit the grazing of treated crops and/or feeding of crop stubbles, by-products or wastes to livestock.

Organochlorine (OC) residues have been found in stock fed waste plant material, particularly root vegetables (potatoes, carrots, etc.) and cucurbits (pumpkin, squash, zucchini, marrows, etc.) that had been grown on OC contaminated land. When fed as a major part of the diet and/or for prolonged periods, trace levels of OCs in the attached soil or on the vegetable's skin build up in the animal's body fat. OC residues in stock have also come from the feeding of wastes, such as sugar cane tops and cotton trash, sourced from OC contaminated land and from materials stored in OC-treated silos, bins, etc.

OC chemicals such as dieldrin and DDT have a half-life of four to six months in cattle. Stock with OC residues may require many months on residue-free feed before they meet market standards.

Chemical residue risk assessments

To avoid residue risks, it is recommended that only conventional stock feeds be fed to stock producing food for human consumption. These feeds should be certified as suitable for that purpose by an accompanying stock feed commodity vendor declaration (CVD). Where this is not possible, there are other approaches that producers may use to protect themselves and their industry from potential loss.

To ensure the quality of meat and milk products, livestock producers must assess the chemical residue status of any stock feed, including processing wastes and by-products, before feeding them to their stock.

Generic risk assessments

Generic residue risk assessments have been done on a number of plant by-products that are sometimes fed to stock, including apple pomace, citrus pulp, cotton trash, grape marc, sugarcane, sugarcane tops and waste vegetables.

Such assessments considered all of the chemicals that were registered for use on the crops from which these by-products are derived. The likely type and level of residues in both the by-product and in stock fed those by-products were identified. The time taken for residues to deplete from the stock was also considered along with the Australian and international MRLs for the chemicals in question.

The assessments generally indicated that after spending 60 days on 'clean' feed, stock previously fed these by-products should meet domestic and export residue standards for the registered chemicals considered in the assessments.

Cattle fed by-product stock feeds in the 60 days prior to slaughter can be identified through the answer to Question 4 on the National Vendor Declaration (NVD) for cattle (see below).

The assessments also noted that some by-product stockfeeds, such as cotton trash, sugarcane, sugarcane tops and vegetable wastes could contain OC residues if the parent crops were grown on OC-contaminated land. Such materials should not be fed to stock unless they are first tested to ensure that livestock diets will not exceed the MRLs set for OC residues in stockfeeds.

Limitations of generic risk assessments

However, the generic risk assessments do have limitations including:

- » For a small number of chemicals, there was insufficient information to assess the likely residues in the by-products and/or in stock that were fed those by-products and/or to estimate the time taken for residues in stock to fall below detectable levels.
- » The assessments assumed that all chemical treatments were done in accordance with label directions using only chemicals registered for use on the crops in question and that all relevant withholding periods were observed.
- » The assessments only considered chemicals that were registered for use on the parent crop or commodity when the assessments were done.
- » The possibility of OC contamination was considered for some by-products where the parent crop may have been grown on OC-treated land (cane tops, cotton trash and waste vegetables).
- » Other possible chemical exposures, from spray drift or during processing, transport or storage, were not considered.

Specific risk assessments

A comprehensive residue assessment is only practical where the full chemical treatment and exposure history of the proposed stock feed is known. Such an assessment should determine if:

- » all chemical treatments were done in accordance with label directions
- » the label directions for any chemicals used prohibit the feeding of wastes from treated crops
- » all chemicals used on the parent crop or on the stored commodity or waste have grazing/fodder withholding periods
- » those withholding periods were observed before harvesting or processing the commodity.

Further inquiries may be needed to determine whether the material was exposed to other chemicals at any time - such as from spray drift or during storage or transport.

If the assessment indicates that the material may contain unacceptable residues of particular chemicals then specific residue tests should be done to determine if it is suitable for use as stock feed. The possibility of OC contamination from soil or storage areas should be considered when deciding what tests are needed.

The assessment and laboratory testing results must be interpreted to determine:

- » whether residues are likely to occur in stock fed the material
- » if so, the type and level of residues
- » whether any such residues could exceed Australian and/or overseas MRLs for animal products
- » whether a pre-slaughter period is needed between last feeding the material and harvesting animal products for human consumption, to ensure that the animal products meet relevant MRLs.

If a pre-slaughter period is required, stock fed the material need to be identified and feeding records kept to confirm that they have met the required post-feeding period and are eligible for slaughter or milking.

Marketing implications of feeding wastes

Irrespective of any residue risk assessment done before deciding to feed waste materials, buyers may discriminate against stock that are fed such materials in the 60 days prior to sale.

The National Vendor Declaration (NVD) asks if cattle were fed any 'by-product stock feeds' in the 60 days prior to sale. By-product stock feeds include 'any plant material not produced primarily for livestock consumption, such as waste fruit, vegetables and fibre crops, including peel, pulp, pressings, stem and leaf material'.

A 'yes' answer is appropriate if the stock have been fed any of the materials within 60 days prior to sale.

The NVDs for sheep and cattle ask if, in the 60 days prior to sale, stock have grazed or been fed any pasture, crops, stubble or fodder that was sprayed with an agricultural chemical in the 60 days prior to grazing or harvesting and:

- » the grazing/fodder withholding period was not observed, or
- » the chemical had no such withholding period on the label.

A 'yes' answer is appropriate if materials with an unknown chemical treatment history were fed within the 60 days prior to sale. For many chemicals, residues in contaminated animals will fall to acceptable levels within that timeframe.

Vendors that give false or misleading answers to NVD questions may face prosecution or civil action or both. Producers should always read the questions and the explanatory notes carefully before completing any vendor declaration. If in doubt about the proper completion of NVDs, contact Meat and Livestock Australia's help line on 1800 683 111.

Livestock feeds - prohibited and restricted substances

Anyone intending to feed waste materials to ruminant animals (cattle, sheep, goats, deer, etc.) or to pigs must ensure that it is free from 'prohibited or restricted substances'.

The *Biosecurity Act 2015* and Biosecurity Regulations 2017 restrict the feeding of some materials, to livestock. Part 2, Division 9 of the Regulation says that: a person must not feed a prohibited substance to stock or cause or permit stock to feed on a prohibited substance.

The maximum penalty is 100 penalty units (currently \$11,000).

Prohibited substances in ruminant feeds

For ruminant animals, the prohibited substances are defined as 'restricted animal material' by Clause 34 of the Biosecurity Regulation. They include tissue, blood or feathers derived from the carcass of an animal and any substance produced from or containing any such tissue, blood or feathers.

This definition covers most materials derived from vertebrate animals including feather and fish meals. Only milk products, tallow and gelatine are exempt. For further details on ruminant feeding see *Primefact 313 Feed controls - stopping BSE (Mad Cow Disease)* See:

www.dpi.nsw.gov.au/stock-feed-control

Prohibited substances in pig feeds

Prohibited substances in pig feed include any product from a mammal (including tissue or blood) except if authorised. They are defined by Clause 37 of the Biosecurity Regulation 2017. The feeding of household or commercial garbage or waste that contains the meat, tissue or blood of mammals is also prohibited. These prohibited substances are often referred to as 'swill'. For more information on feeding pigs, contact your Local Land Services District Veterinarian.

Supplementary feeding of cattle

Introduction

Early in a drought there is usually plenty of poor quality dry feed, which animals cannot use efficiently. Supplementary feeding at this stage aims to make better use of this feed by supplying the nutrients that are deficient in the pasture. This allows animals to be cheaply maintained while drought decisions are made.

Supplementary feeding is only an option when there is available paddock feed. When paddock feed becomes limited, survival feeding or production feeding must be implemented. Survival feeding provides an animal with the minimum feed it needs to stay alive. Production feeding for adult stock provides sufficient food for successful breeding and for younger animals sufficient food to meet growth and/or market targets.

Effective supplementary feeding

To be effective, the supplement you choose must make up for the main nutrient deficiencies in the paddock feed. Dry feed is often deficient in protein and sulphur and energy is only available in slowly digestible forms. In cases where the feed is green but very short, low energy intake limits production.

The new '*Drought and Supplementary Feed Calculator App*' developed by NSW DPI simplifies the choices and amounts of supplementary feeds required by different classes of stock under different pasture conditions.

To ensure the efficient use of supplements you should:

- » Identify the most limiting components, usually protein, sulphur and/or energy
- » Select supplements containing high levels of the identified limiting components
- » Balance the supplement to ensure efficient rumen function
- » Remember that young and lactating animals have a greater need for protein
- » Choose feeding techniques that minimise disruption to the animals' digestive system
- » Cost out the program considering alternative measures
- » Feed those animals with the greatest needs, for example pregnant cows of low fat score, or weaners below critical liveweights
- » Monitor feed consumption, liveweight and condition to confirm that your strategy is working.

Outcomes of feeding supplements to stock

The possible outcomes of feeding supplements to stock depend on whether energy or protein supplements are used and on how the pasture and supplement interact during digestion. They include:

- » Supplementation. The supplement is eaten and pasture intake is unchanged. This is a rare event.
- » Substitution. The supplement eaten causes reduced pasture intake. This usually occurs when pasture is supplemented with a high-energy feed such as grain.
- » Complementation. The supplement is eaten and pasture intake increases. This occurs when stock are grazing on dry pasture or crop stubble and the supplement improves the animal's ability to utilise the feed.

Supplementary feeding

Table 11 provides supplementary feeding recommendations for various stock classes of beef cattle.

Frequency of feeding

Non-protein nitrogen sources – such as urea and sulfate of ammonia – dissolve quickly in the rumen and any surplus nitrogen is wastefully excreted. To be effective, the non-protein supplements must be fed in small amounts and often.

Protein meals, such as cottonseed meal or linseed meal, release their protein differently, allowing cattle to use the protein efficiently over a longer period. Twice-weekly feeding is as effective as daily feeding.

High-protein grains (e.g. lupins or peas) are more degradable, with a higher protein release rate and should be fed every second or third day.

Protein meals and seeds

Protein meals and high-protein seeds are excellent supplements when pasture digestibility is falling. Protein meals are oilseed crop by-products. The most common high-protein seeds are white ('fuzzy') cottonseed and lupins.

Both protein meals and seeds can be fed twice weekly in daily amount multiples (see Table 11). They are safe feeds and do not cause acidosis (grain poisoning).

Block licks

Although commercial urea and protein blocks are convenient and can be used with moderate success as supplements to abundant dry feed (over 2500kg dry matter/ha), they cost three to four times as much as high quality protein feed. Better results can be achieved at a fraction of the cost by using legume grains or protein meals. Block licks are most suitable in the early drought phase.

Roller drums

Roller drums supply nitrogen from the urea in a molasses, urea and water mix to maintain liveweight of dry cattle when dry feed is plentiful. They are useful only when dry standing feed exists and they are an alternative choice to protein block licks. Table 12 provides recipes.

Table 11. Supplementary feeding recommendations

Available feed	Class of stock	Supplement	Feeding frequency
Plentiful dry feed » Low pasture digestibility limits intake » Protein supplements increase pasture intake	Cows and calves, dry adult stock	Urea/molasses mix or loose lick to supply 60g urea/cow/day OR Pulse grains, 0.5–1.0 kg/cow/day OR Protein meals, DDG, cottonseed 0.5–1kg/head/day	Continuous access Every second day 2–3 times/week
	Weaners	Supplement and frequency as for other classes of stock, but high-protein grains or meals preferred.	
Short green feed » Low pasture availability limits intake » Feed energy supplements	Cows and calves	Good hay, 3–4kg/cow/day OR Grain, 1–2kg/cow/day + hay 1–2kg/cow/day	2–3 times/week
	All dry cattle	Hay, 2–3kg/head/day OR Grain, 1–2 kg/head/day	Daily or every second day
Deteriorating dry feed » Low pasture availability and digestibility restrict intake » Feed energy/protein supplement mixes » Full hand feeding follows	Cows and calves	Molasses/urea/protein meal OR Cottonseed / DDG / pulses 2–3kg/cow/day	Continuous access 2–3 times/week
	Dry stock	Cottonseed / DDG / pulses 1–2kg/hd/day	2–3 times/week

WARNING: Cereal grains and urea can be poisonous if fed in large amounts before cattle are used to them. Be sure to introduce them gradually to reduce this risk. Rations consisting wholly of grain are not recommended for lactating cows; instead, feed a mixture of 80% grain and 20% hay. Cereal grains should be fed out daily where possible and pulse grains can be fed out daily or every second day.

Table 12. Mixes for supplementary feeding urea/molasses (roller drums)

	First week	Second week	Third week
Water (litres)	100	100	100
Molasses (litres)	100	50	30
Urea (kg) – Prilled	15	15	15

Each mix should last about 30 head for 10 days. To decrease the rate of consumption, reduce the proportion of molasses.

WARNING: Urea can be poisonous to stock.

Grain and hay

In the early drought phase (dry standing feed), grains and hays act as a substitute for paddock feed rather than a supplement. Supplements encourage the use of standing dry feed.

Cereal grains (such as oats or wheat) are not efficient supplements when paddock feed is dry. They produce lactic acid in the rumen, which slows down the digestion and consumption of fibrous paddock feed. You can reduce this effect by feeding small amounts every three days and by adding protein meals, grain legumes or white cottonseed. This will fill the gap between the protein level in the grain and the animal's need for 13–15% protein and 6–10% in the overall diet of younger stock and dry stock respectively. High-protein alternatives such as lupins, peas, or cottonseed meal will give better results while paddock feed lasts.

Grains are more useful when feed is short and green and/ or when hay supplies are low. This is particularly so for dry cattle, which need less roughage. Hay is best for lactating cows on short green feed, particularly in the colder months. The main role of grains is in full feeding when available pasture is low. Cattle should be removed from paddocks to reduce the likelihood of erosion (see the following sections on full feeding).

White cottonseed

White cottonseed is an excellent supplementary feed that is high in energy and protein but also provides fibre in the hulls and lint. It mixes well with grain and protein meals but its high oil content may cause digestive upsets when daily intakes are high for extended periods, or when combined with other feeds that are high in oil such as grape marc or failed canola crop. It should make up no more than a third of maximum potential feed intake when fed out with a suitable roughage source. Cottonseed is a suitable supplement for stock grazing low quality feed,

such as cereal stubble or mature / frosted / drought affected tropical grass pasture with no visible green content. Under these conditions, it can be fed at up to 0.5% of bodyweight for cows, and 0.33% for weaned calves up to the amounts listed below.

For more information on restrictions refer to *Primefact 303 'White cottonseed- a supplementary cattle feed'*.

Table 13. Suggested feeding levels with adequate dry feed available.

Stock class	kg/head/day
lactating cows	2 – 3
dry – pregnant cows	1 – 2
yearlings 250-350kg	1 – 2
Weaned calves 100-150kg	0.5

Molasses

Cattle can be fed molasses-based diets fortified with protein meal and urea if there is roughage in the paddocks or roughage is provided.

Molasses-based diets are versatile and can be used in the early drought stage as a production feed as well as being used in full feeding. Table 4 shows recommended molasses rations, which assume adequate roughage is available.

These fortified molasses mixes are distinct from roller drum mixes. Fortified molasses mixes give superior cattle performance (particularly in lactating cows) than roller drum mixes.

Sources of phosphorus

Traditional sources of phosphorus – MAP fertilisers (e.g. Starter 12®) and DAP fertilisers – are not recommended as stockfeed sources of phosphorus..

The new sources of phosphorus are monocalcium and dicalcium phosphates that are low in fluorine and cadmium (see Table 15).

Table 14. Recommended molasses rations (calculated assuming adequate roughage is available)

Class of stock	Molasses	Cottonseed meal	Urea	Monocalcium or dicalcium phosphate*
30 cows with calves at foot. For lactation and successful rejoining. Feed the mix twice weekly.	250kg (1 drum)	50kg	8kg	3kg
30 cows with calves at foot. For scrub feeding. Feed mix twice weekly.	250kg	25kg	8kg	3kg
30 weaners (200 kg). For normal growth. Feed mix twice weekly.	125kg	50kg	2kg	2kg
30 head of dry stock. For maintenance of weight and condition. Also for scrub feeding dry cattle. Feed mix twice weekly.	250kg	–	8kg	2kg

* Monophosphate or dicalcium phosphate should be included for cattle grazing in phosphorus deficient soils.

Table 15. Suitable sources of phosphorus

Product	Ingredient	Phosphorus content
Kynofos 21®	Monocalcium and dicalcium phosphate (50:50)	21%
Biofos®	Monocalcium and dicalcium phosphate (67:33)	21%
DCP®	Dicalcium phosphate	18%

Managing full hand feeding of beef cattle

Introduction

When there is not enough pasture for livestock maintenance or further grazing of pastures may be detrimental to pasture management or survival, the animals' nutritional requirements must be met by full hand feeding. It is important to begin planning well in advance of starting to feed.

Feed in a confined area

All stock in a full feeding situation should be confined to a small area or a small paddock for the following reasons:

- » To limit pasture and soil degradation
- » Stock health can be more easily monitored
- » Stock do not have to expend energy walking around the paddock looking for food or water, which limits the amount of feed required.
- » Choose an area where the pasture can be regenerated after the drought breaks and any soil erosion will be minimised.

Refer to *Primefact 554 Confinement feeding stock*.

Parasites

Parasite burdens can be greater when stock have lower resistance because of poor nutrition and when they are concentrated in small areas. For example, bulls are highly susceptible to ostertagia (small brown worm) infestations.

Do not overlook the need to treat for fluke in areas at risk from this parasite. Treat all stock for lice and worms.

Vaccinations

A 5-in-1 (or 7-in-1) vaccination given to all stock (including bulls) before grain feeding provides cheap insurance against losses from clostridial diseases.

Vitamin A, D, E injection (intramuscular) is essential for all classes of cattle, particularly if they have not had access to green feed for an extended period.

Stock management

Heifers

If you decide not to sell maiden heifers, they are best withheld from joining. If joined, they must be feed to ensure they develop adequately before calving.

Cows

Pregnancy test all cows that have been joined and sell any that are not in calf and identify any that conceived late as they may also need to be sold. Pregnant cows need close supervision.

Problems may develop during calving because drought conditions can lead to a higher proportion of calving difficulties and retained afterbirths.

Metabolic disorders (such as milk fever) are also more likely to occur. Cows will do better if calves are weaned, as they need less feed and feed quality is less important.

Calves

Calves should be weaned as early as possible- this can be as early as 6 weeks of age with good feeding management – see *Weaning management* on page 27.

Stock should be dehorned as part of normal management. In a drought, polled or dehorned cattle are less aggressive at the feed trough, which means less troughing is required.

If cattle have not been dehorned by the start of the drought, it is advisable to avoid the extra stress of dehorning.

Water

Beware of cattle bogging in dams, soaks and waterholes. Fence off these areas and provide water in troughs where possible. The inflow of water to the trough is as important as trough capacity. Under drought conditions, cattle will drink about 10L of water per 100kg of bodyweight per day, and more in hot weather. Cattle water intake doubles when the daily temperatures increase from 21°C to 32°C.

When water becomes a problem, sell stock to reduce the need to cart water.

Preparing for full feeding

Where necessary, draft stock into management groups based on weight and body condition. Stock are easier to manage and supervise when they are confined to small paddocks close to feed supplies.

Grain feeding

Starting cattle on grain

To reduce the risk of grain acidosis, be vigilant when introducing cattle to grain and pelleted rations. The high starch content of most grains can cause health issues. Lupin is the exception because it is low in starch.

Good security of grain stores and standing crops is essential to prevent acidosis issues. For stock grazing stubble with a significant amount of grain, it is a good idea to gradually introduce grain to stock so that the rumen bacterial population adapts over time.

There should also be a minimum of 10–20% roughage in any ration.

Animals should be closely monitored in the introductory phase to grain feeding. Diarrhoea is often the first sign of mild grain acidosis and if this is seen in a number of animals, the proportion of hay in the ration should be increased.

Some grains, for example lupins, are safer to feed than others. Similarly, it is safer to feed oats, which have a higher ratio of fibre to starch than wheat.

When changing between different types or even batches of grains, and especially when changing between batches of pellets, the new feed should be introduced by 'shandying' it with the old and gradually increasing the proportion of the new feed over at least seven days.

Paddock situation

Below is a typical introductory regime to grain feeding in a paddock situation for cattle.

Table 16. A typical introductory regime for increasing grain content in the rations of cattle in a paddock-feeding situation

Day	Amount of hay	Cereal grain (kg/hd/day) for cattle
1–2	To requirements, then grain	1
3–4	Decrease hay fed	1.5
Day 5 onwards	Decrease hay fed	Increase by 500 g/day – until required feeding level is reached

Complete grain and roughage ration

When animals are introduced to a high-grain diet, they should begin on a ration consisting primarily of hay, with the percentage of grain being gradually increased over two to three weeks.

Below is a typical introductory regime for introducing sheep or cattle to a complete diet of grain and roughage.

Table 17. A typical introductory regime for increasing grain content in a complete ration for cattle

Day	% in ration	
	Cereal grain	Hay
1–5	20	80
6–10	40	60
11–15	60	40
16–20	70	30
Final ration	80	20

Including lupins in the ration

Lupins may be used to introduce sheep or cattle to a complete ration with high levels of grain. The high fibre content and low starch levels in lupins make them extremely safe to feed to ruminants and there is no risk of acidosis. The lupins must be fed whole or cracked, but not ground as grinding increases the risk of grain acidosis. The high protein and energy levels in lupins also make them an ideal feed for inclusion in any ration.

Below is a typical introduction to a feedlot ration using lupins.

Table 18. A typical introductory regime for increasing grain content in a complete ration for cattle

Day	% in ration		
	Lupins	Cereal grain	Hay
1–5	80	0	20
6–10	60	20	20
11–15	40	40	20
16–20	20	60	20
Final ration	0	80	20

Frequency of feeding

When cattle are on full drought grain rations, it is safest to feed daily. If you can feed only two or three times a week because labour is scarce or needed elsewhere, be alert to the increased risk of grain poisoning.

Where possible, feed at a regular time of the day to reduce digestive upsets.

Digestibility of grains

Grains are more digestible if coarsely crushed, but the benefits of crushing the grain are questionable if livestock are likely to gorge – which leads to digestive upsets.

Most grains give satisfactory results if fed whole. Some whole grain will pass through in the faeces, but the proportion lost will decrease the longer cattle are being fed whole grain. Grain that is processed too finely may cause digestive upsets and surges in intake.

Digestive losses will vary, depending on the amount and type of grain fed and the length of time animals have been on that feed. The amount passed through by cattle eating whole grain compared with crushed grain varies from about 5% in oats and corn up to about 25% in sorghum.

Adding calcium

Grains are low in calcium so feed finely ground limestone with the grain at the rate of 1 to 1.5kg limestone per 100kg grain. This will prevent acute calcium deficiencies (particularly in lactating stock) and also avoid the poor bone and teeth development that are the long-term effects of calcium deficiency.

Depraved appetite

Bark chewing, hair licking and dung eating can occur when cattle are on grain survival rations. These habits do not pose a health problem. However bone chewing can result in deaths from botulism.

Although grain is generally high in phosphorus and low in calcium, supplements that supply both such as mono- and dicalcium phosphate will reduce this behaviour.

Lactating cows

Cows have low milk yields on all-grain diets and calves suffer accordingly. To help calves survive, feed lactating cows 1–2kg of hay or straw/stubble in addition to grain.

Shy feeders

About 10–15% of stock will not settle down to grain feeding. Shy feeders are best removed from the mob and either fed diets containing some roughage or sold.

Weaning management

Calves are the most difficult stock to feed in a drought. There is no point in feeding them for survival; they need a ration that allows them to grow. Calves need more protein than older stock, which adds to costs, but overall need less feed than other classes of stock.

If you decide to wean and feed calves, the guidelines below will help. Note that, as for all grain feeding, calves should be introduced to grain gradually. See also *Primefact 322 Feeding calves in drought*.

In order to minimise weaning stress, consideration should be given to employing methods which avoid abrupt separation. See <https://www.dpi.nsw.gov.au/animals-and-livestock/beef-cattle/husbandry/general-management/weaning-beef-calves>

Calves over 5 months

Lighter calves, and heifers intended for future breeding, will benefit from adding 75–100 g per head per day of a high-protein feed (such as a meal or legume grain) to normal rations.

Calves 2–5 months

Calves 2–5 months will wean satisfactorily if they are fed a balanced diet. Commercial calf pellets are suitable or you could try one of the following feed mixes:

- » Mix 1: 100 kg lucerne chaff with 100 kg crushed grain.
- » Mix 2: 100 kg crushed grain, 15 kg protein meal and 10 kg roughage (Optional: add 1 kg urea provided that calves have been weaned for 3–4 weeks).

A ration of 1.5–2 kg per head per day is adequate for maintenance, but 2–2.5 kg per head per day will ensure some growth.

Treat these calves against coccidiosis.

Calves under 2 months

Under extreme conditions, calves can be weaned at 4–6 weeks of age if they are given specialised calf rearing meal or pellets with at least 18% protein and good quality grassy Lucerne hay.

Calf health

Provide fresh, clean water, preferably in troughs, at all times. Provide shelter from cold winds.

Treat calves with vitamins A, D and E at weaning and at three-monthly intervals.

Draft off strong calves and feed them away from weak ones and/or according to size to ensure all have equal access to feed. Remove sick and scouring calves from the group and treat them immediately. In particular, young calves are susceptible to coccidiosis.

Treat calves regularly for lice and internal parasites and consider vaccination and/or fly control treatments to prevent pinkeye infections.

Troughing

If possible, put grain in a trough to reduce wastage, dust and health/ residues risks from potential soil consumption. Troughing does not need to be elaborate. Many cheap, temporary methods are satisfactory including:

- » bush timber or railway sleepers placed on the ground 40 cm apart with corrugated iron used as the troughing
- » 200-litre drums split down the middle
- » tractor tyres cut in half with a chainsaw.

Provide sufficiently sized troughs to allow stock to eat together. Allow 30 cm of trough length per head for weaners, 45 cm for yearlings and 60 cm for adult stock. To reduce bullying, several troughs spread apart are better than one long trough. Round feeders allow better stock access than others.

Note that feeding twice the daily amounts every second day can improve feed access for the mob as dominant animals feed and then move away.

Where no troughing is available, place the grain in dumps of about 20 kg each, rather than trailing as for sheep. Dumps are not as efficient as troughs with an expected wastage of 6–8% and a higher risk of sand impaction.

The best value in feeds

Energy requirements for maintenance

Animals need energy, measured in megajoules (MJ) for all body functions. Animal requirements are assessed as megajoules of metabolisable energy (MJ.ME). Energy in feed is assessed as megajoules of metabolisable energy per kilogram of dry matter (MJ.ME/kg feed dry matter or simply M/D). Note that the energy value and its cost is expressed on a weight basis, not volume.

The NSW DPI feed cost calculator allows users to compare energy and protein prices in different feeds. It is available at www.dpi.nsw.gov.au/feed-cost-calculator

The *Drought and Supplementary Feed Calculator App* is available at www.droughthub.nsw.gov.au

Table 19 is a guide to comparing value for money in different types of feeds, based on average feed test results. Read downwards to compare relative costs; figures in the same vertical column represent matching cost per unit of energy. Feeds with a ME less than 7 MJ/kg DM should only be considered as roughage sources rather than energy sources. Feeding them ad lib without concentrates will still result in animal weight loss, as the high fibre in these feeds means that intake is restricted by low rates of digestion.

To compare prices, select a feed from the right-hand column (e.g. wheat) and then select the price per tonne you can buy it for (e.g. \$380). Look down that column to see how much you must pay for other feeds and compare on a 'cost per unit of energy' basis. For example, if barley is more than \$351 per tonne, then wheat at \$380 is a better buy. The cost per unit of energy is the same where wheat is \$380, barley \$351, medium quality oats \$322.

Table 19. Feed price equivalents for drought feeding based on energy values of feed

ME* (MJ/kg DM)	\$ per tonne									Examples of feeds
13	180	220	260	300	340	380	420	460	500	Maize, wheat, triticale, sorghum, lupins, peas.
12	166	203	240	277	314	351	388	425	462	Barley, good quality oats.
11	152	186	220	254	288	322	355	390	420	Medium quality oats, most nuts.
10	138	169	200	231	262	292	323	354	385	Poor quality oats, good legume hay.
9	125	152	180	208	235	263	291	319	347	Good pasture and cereal hay.
8	111	135	160	185	209	234	258	282	306	Medium quality hays.
7	97	118	140	162	183	205	226	248	270	Poor quality hay.
6	83	102	120	138	157	175	194	213	232	Stubbles, cottonseed hulls.
5	69	85	100	115	131	146	162	178	194	Rice hulls, sunflower hulls, rice straw.

This is the energy value of feed (ME = metabolisable energy; MJ/kg DM = megajoules per kilogram of dry matter). Most grains and hays contain about 10% moisture. When buying feeds with a higher moisture content, for example molasses and silage, ensure that the price reflects dry matter content. Feeds in the shaded area should be considered sources of roughage rather than energy.

Remember to consider:

- » wastage levels and the practicalities of handling and feeding out
- » the amount of hay needed for cold weather, for lactating stock, when introducing full grain rations, and for shy feeders
- » suitability of the feed – low-energy feeds (ME 7 or lower) are not be suitable for feeding to young stock over a prolonged period
- » grains fed whole are lower in feed value than the same grains cracked or rolled but reduce the risk of digestive upset
- » supplements are needed with some feeds – this could mean the addition of protein or minerals such as limestone
- » Feed tests are essential in determining the actual value of livestock fodder.

For assistance in calculating relative feed costs use the Feed Cost Calculator at www.dpi.nsw.gov.au/feed-cost-calculator or the Drought Feed Calculator Phone App (see Appendix 2). The Drought Feeding app is available at www.droughthub.nsw.gov.au www.dpi.nsw.gov.au/animal-feed-testing

When the drought breaks

Many properties experience their heaviest losses immediately after drought-breaking rain. Prolonged wet conditions turn animals off their feed. Problems exist under these circumstances if grain is being fed on the ground. As soon as the first green pick emerges, cattle may chase this, expending more energy.

It is essential that cattle are kept confined to designated feeding areas until adequate pasture is available. At that point, allow increased grazing time each day until full grazing is provided after six to seven days. Allowing immediate full grazing will lead to digestive disorders.

After a drought, weeds recover faster than desirable species. Observe how the pasture is recovering and decide on a management strategy if weeds show signs of dominating.

Full hand feeding of beef cattle – quantities

Assessing the situation

When your cattle reach the point where they should not lose any more weight and supplements are insufficient to maintain weight it is the time for a major reassessment.

Consider the following:

- » the probability of useful feed growing if the drought breaks in the near future
- » the quantity of feed required for full feeding
- » the resources required (including finance to buy feed, pay for labour and other continuing costs) and the facilities or equipment required
- » the potential benefit of continuing to feed certain classes of stock.

Cost your program on a monthly basis but keep in mind that there may be a considerable lag time of availability to process stock at abattoirs. You can reassess the stock you are going to feed and perhaps reduce numbers again to stretch available funds.

In full drought the cost of a feeding program will increase, particularly during periods of production stress such as calving and lactation. It may be necessary to cull more heavily.

Energy requirements for maintenance

Animals need energy, measured in megajoules (MJ) for all body functions. Animal requirements are assessed as 'megajoules of metabolisable energy' (MJ ME). Energy in feed is assessed as 'megajoules of metabolisable energy per kilogram of dry matter' (MJ ME/kg DM, or simply M/D).

A drought feeding program should address dietary energy. The energy requirements of cattle depend on:

- » liveweight
- » energy concentration of the feed (M/D)
- » pregnancy
- » lactation
- » growth
- » weather conditions.

Calculating the feed requirement for maintenance

The first step in finding the energy needs of adult cattle is to calculate the amount of feed needed to provide sufficient energy to maintain liveweight. If cows are pregnant or lactating, adjustments to the maintenance value need to be made, and these are discussed in Step 2 of the next section 'Adjusting the ration'.

To calculate the feed requirement for maintenance, you need to know the energy content of the feed or feeds. Appendix 1 contains a guide to the energy contained in various feeds. The values given are average values.

Whenever possible, a feed analysis is recommended, as there can be considerable variation. See 'Feed quality service' on page 50 for information on testing laboratories.

Once the energy content of the feed is known, use Figure 2 to predict the amount of feed needed to meet maintenance requirements. Where more than one feed is being fed, the following procedure is used to calculate the energy content of the mixed ration. It is this number which is then used in Figure 2.

Example

A ration contains 80% wheat (12.9 M/D) and 20% clover hay (8.9 M/D). The calculation is as follows:

$$\text{Energy content} = \frac{(80 \times 12.9) + (20 \times 8.9)}{100} = 12.1 \text{ M/D}$$

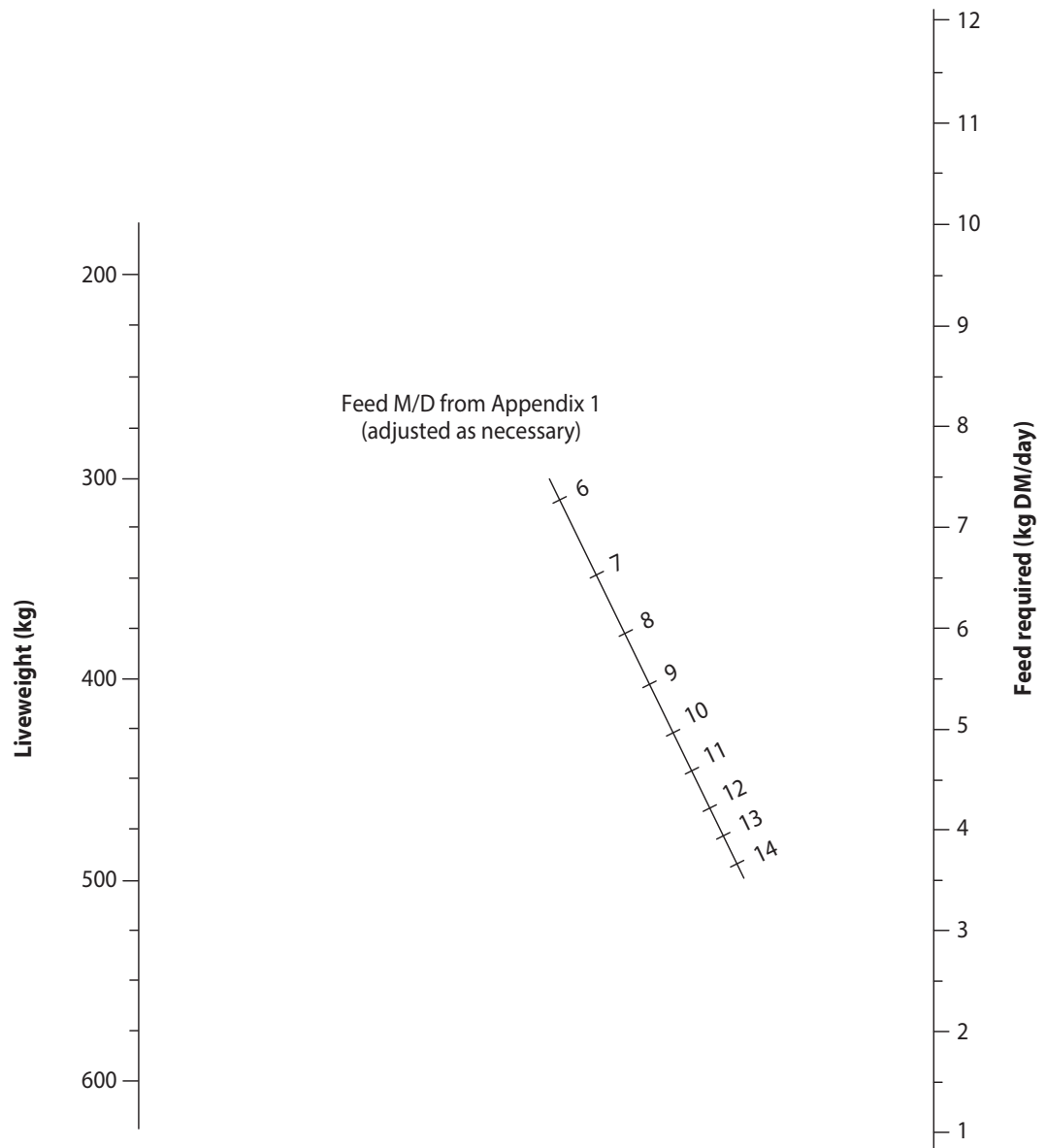


Figure 2. Cattle maintenance requirements

To use Figure 2, place a ruler on the appropriate point which represents the liveweight of the animal under assessment (left-hand vertical line of the figure), then run the ruler through the energy content of the feed (centre angled line). The point where the ruler cuts the right-hand line indicates how much feed (in kilograms per day of dry matter) should be fed to maintain liveweight.

Calculating the 'as fed' amount

The calculation in the previous section assumes the feed is 100% dry matter. All feeds will contain some moisture, and this needs to be compensated for when determining how much of the fodder to feed.

Appendix 1 contains dry matter percentages for various feeds. To determine the amount of a particular fodder or ration to feed, take the calculated amount from Figure 2, multiply it by 100, and then divide this by the dry matter percentage. This is commonly known as the 'as fed' amount.

Example

6.5kg DM/day, where the dry matter percentage is 90%:

'As fed' amount = $6.5 \times 100 \div 90 = 7.2\text{kg}$

As a general rule, to adjust the amount of feed to an 'as fed' weight:

For grains/hay:

'As fed' amount = feed required (kg DM /day) $\times 100 \div 90$

For silages:

'As fed' amount = feed required (kg DM /day) $\times 100 \div 30$

Adjusting the ration

Step 1. Ration for dry beast

Use Appendix 1 to get the energy (M/D) value of the feed. Then place a ruler on Figure 2 at your values for 'Liveweight (kg)' and 'Feed M/D', and read off the 'Feed required' from the right-hand side. Then adjust for dry matter content to calculate the 'as fed' quantity.

Step 2. Allowance for pregnant and lactating cows

Using Figure 2, first calculate the feed requirements for maintaining a non-pregnant cow. Then increase this by the percentage factor given below to determine the corrected amount of feed required by a pregnant or lactating cow:

Cow 6 months pregnant: add 20%

Cow 8 months pregnant: add 40%

Cow with calf at foot: add 60%

Step 3. Allowance for cold stress

During cold, bleak weather, increase the rations for all classes of stock by 20%. The extra feed should be provided as hay.

Wet feeds such as silage or vegetables should be fed in greater quantity in proportion to their moisture content. See the section 'Calculating the 'as fed' amount'.

Feeding for survival

Feeding grain for survival involves the gradual introduction of grain or other high quality feed, otherwise deaths will occur. The success of feeding depends on starting well before cattle fat scores / condition scores fall to their critical levels as highlighted in the diagram below.

The sketches show critical body condition scores for cattle (top) and the implications for management of cattle within these levels. Reproduced from Meat & Livestock Australia's "A national guide to describing and managing beef cattle in low body condition publication" at www.mla.com.au/publications

Level of low body condition	B-E 1/BCS 2	D 0/BCS 1	E 0/BCS 0
<i>Bos taurus</i> or cross bred animals			
<i>Bos indicus</i> animals			
Brief description	Lean but strong and healthy with evident muscle wastage	- Healthy but with significant muscle wastage - Able to recover for transport	- Weak, with no body reserves. At risk of death from cold, wet weather or other stressors - Recovery for transport dependent on high quality care but will be slow
Backbone	Easily seen	Spines of backbone identifiable	Spines of backbone individually identifiable

National livestock language		Body condition score	Welfare	Management
Muscle	Fat			
E	0	0	- High risk - Weak, with no body reserves	- At risk of death from cold, wet weather or other stressors - Recovery dependent on high quality care and will be slow - Unable to be transported without prolonged intensive management
D	0	1	- At risk - Significant muscle utilisation and may be weak	- Able to recover with adequate care - High level of management required - Unlikely can be transported without feeding and rest
B-E	1	2	- Of concern - Lean but strong with evident muscle utilisation	- Management intervention required - May be able to be transported if strong and dependent on journey and prevailing conditions
A-E	2	3	No concern	Minimum target for females at calving
A-E	3	4	No concern	Optimal for breeding
A-E	4	5	No concern	Optimal for breeding
A-E	5	5	At risk of travelling long distances	May be too fat for joining heifers and some cows. Can be transported if heat load is not excessive
A-E	6	5	At risk of travelling long distances	May be too fat for breeding. Can be transported if heat load is not excessive

- Management needs to recognise an animal may have muscle strength but can still be fatigued without adequate rest.
- Management priorities include: weaning, adjusting stocking rates, energy supplementation, protein supplementation, segregation, protection from elements and rest.
- Management intervention should consider the welfare state and strength of individual animals not just the mob.
- Management intervention should only occur after careful planning to consider current and forecast seasonal and environmental conditions as well as all nutritional and relocation options.
- All management decisions should meet the guidelines contained in the publication, *Is it fit to load? A national guide the selection of animals fit to transport (2012)*.
- All management decisions involving the transport of cattle must comply with the standards contained in the publication, *Australian Standards and Guidelines for the Welfare of Animals – Land Transport of Livestock (2012)*.

Figure 3. Cattle considered to be welfare risks (body condition scores of 0 – 1) should be fed the minimum amounts presented in Table 20.

Suitability of various feeds

Grains

Grain is usually the most economical feed to use during drought. Wheat, barley, oats, rice, maize and sorghum are energy-rich feeds with similar nutritive values. They contain sufficient protein to meet the requirements of adult stock and are all suitable for drought feeding. Grains are low in calcium, so 1.5% limestone (superfine grade) by weight must be fed with all-grain diets. Grain introduced too rapidly or eaten in excess can cause sickness and death.

Molasses

Molasses is very suitable for supplementing paddock feed because it can be used as a carrier for other components such as protein or minerals. Molasses has about 70% of the energy value of grains. Because the protein content is negligible, molasses is usually fed with a high-quality protein meal or with urea. Note that if urea is fed to excess or introduced too rapidly, it can be toxic and cause stock death. Sixty grams of urea per head per day is the maximum recommended intake.

Molasses can be safely fed undiluted in troughs. Where molasses is the main feed, cattle usually regulate themselves to about 1kg per 100kg of bodyweight per day. Some roughage should be available to avoid molasses toxicity.

Protein-rich meals including Distillers Dried Grain (DDG)

Cottonseed, canola, soybean, linseed, sunflower and other meals are rich in protein and can be used as special-purpose supplements for young stock in association with energy feeds. They provide a certain amount of bypass protein and increase animal performance more than urea. Most of the energy is provided as oil, so rations should not contain more than 30% of these components. Consider providing limestone when feeding out DDG because it is low in calcium.

Prepared feeds

Cattle and sheep nuts vary in quality between manufacturers and even between batches. Their energy value is generally slightly lower than that of grain. They are a convenient but expensive form of energy and can cause digestive upsets similar to those caused by grain. When introducing and using prepared feeds use the same precautions as for grain.

High protein nuts/pellets generally supply protein in some combination of true protein and urea. They are convenient to use and should be compared to other sources using a feed cost calculator.

Hay

Hay is a necessary drought fodder for:

- » introducing stock to grain
- » feeding during periods of cold stress
- » feeding lactating cows
- » production feeding.

Lucerne hay and good pasture and cereal hays are adequate for maintaining stock. The energy value of 3kg of these hays is equivalent to the energy value of 2kg of grain. Lucerne and clover hays are high in protein, calcium and vitamin A, and are particularly suited to young and lactating stock.

Poorer quality hay and straw barely meet stock maintenance requirements with 2kg equivalent to 1kg grain. The fibrous nature of these feeds will limit the amount a beast can eat. They are usually low in protein and are not suitable for young or lactating stock without the addition of grain or a mixture of molasses and a high-protein feed.

Where lactating cows are being fed grain/hay (80:20), then using a good quality hay means 1.5kg roughage/hd/day and a low quality hay 2.5–3.0kg/hd/day.

Table 20. Feed requirements 'as fed' (kg/head/day) for full hand feeding of cattle.

Stock class	Liveweight (kg)	Grain* 12MJ ME	Hay 8.5MJ ME	Pit silage 35%DM 8.5MJ ME	Bale silage 45%DM 10MJ ME	Grain:hay 50:50	Grain:hay 80:20
Young stock gaining 0.2kg/d	200	3	5	13	8	4	3.5
	250	3.5	6	15	9.5	4.7	4
	300	4	7	17	11	5.5	4.5
	350	4.5	7.5	19	12	6	5
	400	5	>9MJ ME required		13	6.5	5.5
Dry stock at maintenance	450	4.5	7.5	18	12	6	5
	500	5	8	19.5	13	6.5	5.5
	550	5.5	8.5	21	14	7	6
8 month pregnant cow (no gain)	500	7	8	19	18	9	8
	550	7.5	8	20	19	9.5	8.5
	600	8	Not achievable >9MJ ME required		20	10	9
	650	8.5			21	10.7	9.5
Lactating cow (no gain) with calf	500	Not suitable 20% roughage required	Not achievable >10MJ ME required to maintain cow weight		25	12	10.5
	550				26	12	11
	600				27	13	11.5
	650				28	14	12

* Calculations are for crushed grain. Feeding whole grain can increase the amounts required. Increase all amounts by 20% in cold weather, using hay where possible.

Silage

Silage is suitable for cattle and can be self-fed or fed daily as a restricted ration. If feeding weekly, silage should be fed in dumps rather than trails. Most types of silage are comparable in energy value on a dry matter basis, but lucerne silage and clover silage have a higher level of protein.

The feed value of wet silage is variable because of differences in palatability and moisture content. Although the crude protein of silage is similar or higher than hay produced from the same material, its degraded nature means it is used less efficiently, especially by sheep.

The dry matter of most silage varies between around 30-35% for fine chop pit silage and from 45% to 55% for baled silage. The risk of poor fermentation and subsequent low intake due to palatability is unlikely at these DM percentages. To calculate the amount of silage to feed, see the section 'Calculating the 'as fed' amount'.

Irrigated feed

Stock may be given daily access to irrigated fodder crops, as follows (assuming no limit to availability and quality):

» Weaners	2 hr/day
» Yearlings	2 hr/day
» Adult dry stock	1 hr/day
» Breeders, late pregnancy	2 hr/day
» Breeders, lactating	3 hr/day

By-products

Hulls leftover from the oilseed crushing industry are low in protein and energy but can help maintain grown cattle or serve as a source of roughage.

Hull quality varies depending on the amount of kernel left after crushing. For example, cottonseed hulls are better than sunflower hulls, while rice hulls are hard to digest and can injure the gut lining. When used, rice hulls should make up only a small proportion of any ration.

At times, other materials may be available, for example citrus pulp and cannery waste. The feeding value of such by-products should be analysed before determining a feeding program.

Information on accredited residue testing services is available from the National Association of Testing Authorities (www.nata.com.au) or phone 1800 621 666

The value of unusual feeds in drought

A wide range of unusual feedstuffs can be safely and effectively fed to livestock during drought. However, livestock producers need to fully evaluate the feed value, risks, practicality and real cost before replacing more conventional feeds.

Many of these products are low in nutritional value, bulky to transport, difficult to handle, may contain high levels of chemical residues and can be difficult to consistently source.

These products should be evaluated on a dry matter and feed value basis as some very high moisture feeds may have a low cost per tonne but work out to be very expensive on a dry matter basis, particularly when freight is included.

You should also ensure that unusual feedstuffs do not include any restricted materials such as meat, fish or feather meal, bone or blood meal, poultry litter or pet foods. Spent mushroom compost is also unacceptable unless it is free of any poultry waste.

It is safest not to feed unusual feedstuffs to stock without establishing that the material is suitable. Ask the supplier to supply a Commodity Vendor Declaration, to ensure that the feed is suitable for stock and doesn't contain residues or restricted animal material.

Use of by-product stockfeed must be disclosed accurately on any National Vendor Declaration you complete. By-product stock feeds include 'any plant material not produced primarily for livestock consumption, such as waste fruit, vegetables and fibre crops, including peel, pulp, pressings, stem and leaf material'. It does not include grain and grain by-products, cottonseed, oilseed meals, tallow or molasses. A 'yes' answer to Question 4 on your NVD is appropriate if the stock in question have been fed a by-product feed within 60 days prior to sale.

Unusual feedstuffs should be tested for chemical contamination by an accredited testing laboratory before they are used as a drought feed. However, this screening typically only tests for a narrow range of chemicals.

Testing should also be carried out for nutrient value of unusual feeds. Composition may vary widely between samples of the same product from different sources. Consider the energy value (MJ/kgDM), protein content and dry matter percentage as well as the dry matter digestibility of the feed (Dry Matter Digestibility- DMD%). Some alternative feeds may appear to have acceptable energy and protein levels but may be low in digestibility, which restricts the intake and availability of nutrients.

Use the NSW DPI feed cost calculator to calculate the cost of nutrients in a feed.

Most unusual feeds should be used with caution and introduced into rations gradually over two weeks. It is recommended that these feeds comprise no more than around 30% of the total ration. Stock may not be able to eat enough of those feeds with low digestibility/ low nutrient value to meet their energy needs and may die from starvation unless fed with higher digestible or more nutrient dense feeds.

Some unusual feedstuffs include:

- » **Bread:** High in carbohydrates but low in fibre – risk of grain poisoning so introduce slowly.
- » **Biscuit waste:** Similar to bread but extremely variable in nutrient value.
- » **Brewer's grain:** High moisture content restricts delivery distance but a good energy and protein source. Storage requires care or can be ensiled.
- » **Cane tops:** Beware of residues. Low in nutritive value.
- » **Citrus pulp:** Composition varies depending on type of fruit and whether skins and seed included. High moisture content limits area of use due to freight cost. Limited storage life but can be ensiled with other materials. Low in calcium. Must be introduced gradually – lemon is more acceptable than orange or grapefruit.
- » **Cottonseed hulls:** Palatable but low in feed value.
- » **Grape marc:** Generally low and variable in feed value and moisture content. Most of the energy is contained in the seed but unless the product has been ensiled (e.g. Nutra marc) the seeds are generally not digested by cattle. However, if they are digested then be aware of high oil content of rations when fed with cottonseed.
- » **Onions:** Known to cause anemia and cattle deaths and should be avoided or used in small amounts with extreme caution.
- » **Potatoes:** High moisture content, low protein but good energy source. Palatable. Some risk of choking. Avoid sprouted potatoes or those that have turned green as a result of exposure to sun.
- » **Pumpkins:** Need to be chopped.
- » **Rice hulls:** Little feed value, abrasive and can cause impaction if fed at high levels.
- » **Rice Straw:** Beware of residues. Low in nutritive value. High silica and oxalate levels may cause problems.
- » **Sawdust:** Has no nutritive value at all but at levels up to 15% can be used as a roughage substitute to facilitate rumen function. Hardwood is preferable to cypress pine.
- » **Vegetable/Fruit wastes:** e.g. cabbage, carrots, whole apples, oranges – beware of residues. Can have high moisture content.
- » **Waste paper:** Little feed value. Printed paper may contain toxins.

Table 21 is a guide to the average composition of some alternate feeds but producers are strongly urged to have products analysed before purchase.

Source: NSW Department of Primary Industries feeds database, and FeedTest®, Department of Primary Industries, Victoria.

Table 21. A guide to the average composition of some alternate feeds.

Product	Dry Matter (%)	Crude protein (%)	DDM* %	Energy ME (MJ/kg DM)
Bread	62–85	13.5–18.2	85–89	12.8–13.4
Brewers grain	20–30	17–30	–	9.5–10.0
Cane tops	84.9	2.7–3.5	27.5	3.8–8.3
Citrus pulp	18–25	7.5	–	10.4
Cottonseed hulls	93.4	4.0–11.5	35.5	2.9–6.3
Grape marc	49.1–51.6	11.2–16.1	25.1–48.8	3.8–7.3
Potatoes	16–25	7–14	84–86	10–12
Pumpkins	9	16	–	13
Rice hulls	92.3	2.0–3.1	23.3	2.4
Rice straw	52–93	2.2–9.0	30–55	3.1–7.5

* Digestible dry matter.

Managing dairy cattle

Herd numbers and feeding levels must be constantly assessed during feed shortages. Reducing stocking pressures by agistment or culling and selling are ways to cope with feed shortages. However you decide to manage your herd during feed shortages, grouping stock according to feed priorities is important.

Groups of stock

Early-to-mid lactation milkers are the main income earners and require high intakes of good quality feed to maintain moderate to high levels of production. These stock are the most responsive to improved feeding levels and will suffer the most from restricted or poor quality diets. Underfed cows will be difficult to get back in calf, and their milk production will be less likely to recover once the season breaks and there is pasture available.

Late lactation stock partition feed to body weight rather than milk. They should be maintained at a minimum condition score of 4.5 to 5.0 (on the 1 to 8 scale). Check joining records and pregnancy testing to determine dry off date. It is usually more profitable to keep cows in the milking herd and feed them well until dry off date, rather than putting them in the dry paddock.

Forward springers should be maintained in good condition, and fed a transition diet for 14–21 days prior to calving. This will help reduce calving problems, and prepare the cow for the demands of early lactation. Backward springers in poor condition that are expected to calve within two months require supplementation to maintain weight or make some weight gains. Stock in moderate to good condition should be held at this condition while stock with long dry periods can be fed a maintenance ration.

Unmated heifers are the future milkers. If fed a maintenance ration they should be left unjoined. To allow proper attention to a reduced and selected number of stock, it is essential to determine the numbers essential for a replacement program. It is undesirable to feed weaners a maintenance ration for an extended period of time. Poor growth rates of replacement heifers will reduce their lifetime milk production and fertility. Selecting a small group that can be correctly fed to maintain growth is the best strategy.

Calves can be fed a milk replacer once they have received colostrum for the first 24 hours. They may be weaned from milk onto dry feed at 4–6 weeks providing they are eating 0.5kg to 0.75kg of high protein concentrates a day.

Selective reduction of stock

Even if cattle prices are low, it is often more economical to sell sub-standard stock during feed shortages and droughts than to hold on to them. Early disposal of low producers, poor quality replacements and problem cows in good condition reduces the total cost of feeding and increases the price received from their sale.

The availability and cost of agistment depends on the extent and duration of the dry spell. Reducing stock numbers places less stress on your property and reduces the time and cost of feeding surplus stock. Your property will also recover more rapidly at the end of the poor seasonal conditions.

Agistment considerations

- » Prevent unwanted matings
- » Springers brought home before calving.
- » Safe paddocks to prevent accidents and to stop stock from straying.

Stock husbandry

- » When there is no paddock feed, confining stock to small paddocks allows better supervision and reduces the amount of energy the animals expend walking. Providing shade in summer and shelter in winter reduces the amount of food used for thermal comfort.
- » Ensure proper and sufficient water supplies at all times.
- » Separate stock into production groups or weight groups to improve feeding schedules. Young stock should be separated from older stock to prevent bullying and ensure adequate feed intake.
- » Stock stressed by drought conditions have an increased susceptibility to internal and external parasites. If infected they require treatment, but care should be taken to avoid stress on weak, underfed stock.
- » Ensure that all stock are also protected against clostridial diseases (e.g. blackleg, pulpy kidney).
- » Cows calving in poor condition require close supervision to reduce problems associated with calving difficulties and metabolic disorders.
- » If necessary, appropriate veterinary treatment must be provided, or where necessary to prevent suffering and distress humane destruction should occur. For more detailed information on the humane destruction of stock download the *Primefact 310 Humane destruction of stock fact sheet* at www.dpi.nsw.gov.au/stock-destruction

Full hand feeding of sheep – management

It is important to carefully consider the available drought strategies at the beginning of a drought. Keep in mind that as the drought progresses, your options for action decrease.

Making a decision about drought strategies will require assumptions to be made about drought length, stock prices and feed costs. Always use the best available information to support these assumptions and when new information becomes available use this to re-evaluate your current plan.

It is essential to develop a series of budgets ranging from the best case to the worst-case scenario to help you choose the most cost effective strategy. Keep in mind that under-estimating drought length will usually be a more costly mistake than an overestimate because of the different strategies that would be put into place.

Stock culling priorities

Reducing sheep numbers is the simplest way to stretch the available feed. If you are forced to sell stock because of drought, there are provisions to allow income, for tax purposes, to be carried forward into the next financial year.

Contact the Tax Office or your accountant for details.

As the drought progresses, it is worth keeping only the most productive sheep (that is, those that you anticipate will contribute greatest to cash flow following the drought).

This is the priority order for the disposal of sheep:

- » all unthrifty sheep and sheep in poor health including those with conformation faults (for example, poor mouths and feet, and damaged udders) diseased sheep and cull weaners
- » wethers and aged ewes
- » dry ewes
- » weaners
- » quality breeding stock.

Good-quality breeding ewes and rams are the most valuable sheep at the end of the drought and will need special care if breeding programs are to be maintained.

Making hard decisions and selling stock while they are in good condition minimises the difference between selling price and buy-in price after the drought.

Supplementary feeding

Feeding in dry spells often starts well before it is clear that drought has arrived. During these periods, stock are fed a supplement to the available pasture. The types and quantities of supplement will vary according to the current condition of the stock, the quantity and quality of pasture still available, and the production target set for these animals.

Efficient supplementation requires a balance between energy and protein intake. The GrazFeed™ computer decision support tool developed by CSIRO can help you formulate appropriate supplements. It is available from Horizon Agriculture at www.hzn.com.au

When to start feeding

In practice, feeding is likely to have started as part of the supplementary feeding phase, ensuring sheep weights are well above those indicated in Table 22.

The level of supplementation should gradually be increased to a full drought ration just prior to animals reaching the desired weight or fat score target.

If no supplementary feeding has occurred, feeding should start earlier, when animals are 3–4 kg above the desired maintenance weight to allow for additional weight loss during grain introduction.

Table 22 shows the minimum liveweight for various types of sheep (based on frame size) at which dry sheep should not be at risk. These weights should ensure sheep are maintained at a fat score of 1.

Productive sheep (breeding ewes) should be maintained above these weights. Fat scores in the range of 2–3 (especially if sheep are pregnant or exposed to cold conditions) should be the minimum objective.

If a long period of cold weather is anticipated, set target weights 5 kg heavier to allow a greater safety margin.

Note: If fat score 1 is the target, the lightest, worst-conditioned animals in the mob may need to be separated and fed earlier than for the average.

Table 22. Minimum liveweight for shorn adult sheep in drought.

Animal class	Minimum liveweight (kg)
South Australian merino, crossbreeds, British breeds (65 kg at 3 fat score)	50
Peppin-type merino and large frame fine wool merino (55 kg at 3 fat score)	40
Smaller framed fine and superfine wool merino (45 kg at 3 fat score)	35

Training sheep to feed

It is good practice to include in the mob some sheep that have been fed previously. This encourages the inexperienced sheep to feed.

Untrained sheep are best educated in small paddocks. Start by scattering a highly palatable fodder such as lucerne or clover hay to encourage sheep to start feeding. Holding sheep near to the feed may also be necessary. Do not feed the sheep again until most of the hay is eaten. When the sheep are readily eating the hay, introduce a small quantity of grain (see Table 27).

A general policy of educating lambs to grain feeding prior to weaning (even in good years) will eliminate the often laborious and time-consuming task of starting sheep to feed. It has been shown that lambs that see their mothers eating from a grain trail will more readily adapt to hand feeding, even if some years pass before they are fed again. Just three to four feeds with their mothers with the grains most likely to be fed at some time in the future will be sufficient.

Monitoring the feeding program

Woolly sheep often look in much better condition than they really are. The weight of animals ignores the fact that sheep can be heavy because of large frame size but may carry little in the way of fat reserves. Manually assessing fat score helps to put the liveweight into

the context of a fat score target. Changes in fat score and liveweight provide an objective method to determine the adequacy of existing feeding levels. Feeding decisions based on fat scoring and liveweights will ensure more efficient use of feed.

Monitor a small portion of the mob on a regular basis. Fat scoring and weighing 50 sheep from a mob of 500 will show if there has been a change within the mob. It is important that these same sheep are assessed on each occasion.

Refer to *NSW DPI Prograze Manual, Ninth Edition Segment 4; Sheep Breeding Package* on the technique of fat scoring sheep and lambs.

Pregnant ewes

Special attention needs to be given to the nutrition of pregnant ewes to prevent mortalities. To ensure adequate lamb birth weights and ewe mothering ability, pregnant ewes should be at least fat score 2 throughout pregnancy and preferably score 3. Although placental development takes place in the first three months of pregnancy, ewes will be adequately maintained with a ration suitable for a dry sheep of the same weight.

Growth of the foetal lamb accelerates during the final six weeks of pregnancy and the feeding rate needs to be increased accordingly. The total increase in weight of the conceptus (including the foetus) during the last six weeks of pregnancy amounts to about 10kg for ewes with a single lamb and more for a mother with twins. Ewes need to increase their gross liveweight by this amount if they are to maintain their own body condition.

Lamb birth weights of over 3.5kg will ensure good survival rates. However, this is unlikely to occur in drought. Under-nutrition during late pregnancy reduces mothering instincts of ewes. In these circumstances, it is common to see ewes abandoning their lambs shortly after birth.

Splitting mobs into early and late lambers or according to twins and singles will enable more precise feeding and will potentially save on the cost of feed.

Lambing management

Good management in later pregnancy is still no guarantee of live lambs at weaning.

Increased feed requirements after lambing will enable good lactation and lamb survival.

The main causes of lamb deaths during drought are usually a combination of two or more of the following:

- » mismothering
- » starvation
- » exposure
- » delayed or difficult birth.

Ewes in the later stages of pregnancy and newly born lambs should be closely monitored to minimise the chance of lamb deaths.

A maximum stocking density of 18 ewes per hectare is a reasonable guide for a mixed mob containing single- and twin-bearing ewes; and 10 ewes per hectare for twin bearers.

Select lambing paddocks well before lambing starts. Concentrating dry and pregnant stock onto smaller areas will allow lambing paddocks to be locked up early, which may save some pasture for lambing. It may also help avoid hand feeding during lambing, which will reduce the risk of mismothering.

Generally it is the less vigorous lambs that are mismothered. Adequate feeding during the pre-lambing period can reduce this. Self-feeders and daily feeding can help to reduce the problem. Early afternoon feeding reduces the risk of mismothering.

The right paddock and small mob sizes will reduce the incidence of mismothering. Choose small paddocks free of gullies and dense or fallen timber.

Ewes and lambs

After lambing, energy and protein requirements increase dramatically. While grain alone is satisfactory for dry and pregnant animals, roughage is needed to ensure better milk production from ewes. Save your best quality hay for lactation.

Lamb survival and growth are improved if there is at least 20% good-quality hay in a grain-based diet.

Silage can also be used as a roughage source. Silage is used successfully for all classes of sheep, and for a broad range of production levels. Unfortunately, silage is seldom economic to transport due to the high moisture content. Chop length of silage is important — if the chop length is too long, the sheep intake will be significantly reduced. Chop length is less important if round bale silage is offered as a whole bale. Use precision chop harvesting equipment when making silage for sheep.

If oat grain is chosen, its high fibre content is likely to be sufficient without extra hay. However oats are often below 10% crude protein and it is important that diets for lactating ewes contain at least 12% crude protein.

Maintain lamb growth rates above 100 g a day for lambs from smaller framed ewes and 150 g a day for large-frame ewes to improve survival rates.

The nutritional requirements for lactating ewes are described in Table 23.

Weaning

Lambs should be fed grain and hay supplements while they are still on their mothers. If lambs are not 'trained', it will take up to three weeks to bring weaners onto adequate quantities of hay or grain. During that time, substantial weight loss and deaths may occur.

Weaners require high quality rations but have relatively low intake. Weaning lambs early can achieve more efficient use of limited feed resources. Early weaning will also maintain higher ewe condition, increasing conception rates at the next joining. Lambs can be weaned successfully if they are a minimum of 8kg and are at least eight weeks of age.

Weaners

Weaners' weight gain should be enough to achieve 20–25kg by six months of age depending on frame size. Once weaners reach this weight it is acceptable to reduce feeding rates to maintain this weight, but a modest weight gain is preferable.

Incorporate roughage into weaner diets early in the post-weaning phase. Use a high-quality hay comprising at least 20% of the ration. Young sheep have a higher need for protein than older dry ewes and wethers.

Consider finishing prime lamb weaners through a feedlot. A realistic budget is the first step in this process as it may be more profitable to sell the lambs as stores and retain valuable feed supplies for other stock.

Shearing

There is no need to change the time of shearing during a drought, although it may be advantageous to shear cull sheep before selling.

If forced to shear twice in one financial year due to drought, tax provisions allow this income to be carried forward into the next financial year. Contact the Tax Office or your accountant for details.

When shearing, consider how long the sheep will be without feed. Minimise stress associated with shearing especially for pregnant ewes. Sheep need more feed after shearing so more frequent feeding may be required. If extra feed is needed, good quality hay is the best alternative as it avoids digestive upsets.

Provide shelter for sheep after shearing as all sheep are at risk from exposure. Off-shears losses during drought can be severe.

Shelter sheds, sheep coats and sheltered paddocks can all reduce the risk. A well-sheltered and timbered paddock with a north or north-easterly slope with no exposed hills provides protection from high-risk winds. Sheep are less affected by chill once wool length is 3 cm.

Shy feeders

A number of sheep and lambs will not adapt to drought feeding. The proportion depends on age, previous feeding history, ration, feeding frequency and mob size, but up to 10% is not uncommon. The best solution is to remove and feed shy feeders separately. Some of the shy feeders will eventually eat the ration. Those that do not can be fed with good-quality hay or pasture (if available) or sold.

When the drought breaks

Often the heaviest sheep losses are sustained following drought-breaking rain.

Prolonged wet conditions turn sheep off their feed and grain being fed on the ground may largely be wasted. As soon as the first green pick emerges, sheep will often chase this and go off their ration. It is essential that sheep be kept confined to the restricted feeding areas until adequate pasture is available. At that point, allow increasing grazing time each day until full grazing is provided after six to seven days.

Allowing immediate full grazing can lead to digestive disorders.

Full hand feeding of sheep – quantities

The quantity of feed required for full hand feeding depends on the size and stage of production of the animal and also the quality of the intended feedstuff. It is impossible to offer a rule of thumb for the feeding rates for animals without knowing the quality of the feed.

Nutrients

Sheep, whether being fed for maintenance or production, need a balanced supply of nutrients. Nutrients divide broadly into:

- » energy
- » protein
- » minerals
- » vitamins.

An adequate supply of drinkable water is also vital for livestock survival, particularly during drought.

Energy requirements for maintenance

Animals need energy, measured in megajoules (MJ), for all body functions. Animal requirements are assessed as megajoules of metabolisable energy (MJ.ME). Energy in feed is assessed as megajoules of metabolisable energy per kilogram of dry matter (MJ.ME/kg feed dry matter or simply M/D).

In drought, energy is the most limiting nutrient and this needs to be addressed in any drought-feeding program.

Sheep requirements for energy depend on:

- » liveweight
- » energy concentration of the feed (M/D)
- » pregnancy
- » lactation
- » growth
- » weather conditions.

The first step in addressing the energy needs of adult sheep is to calculate the amount of feed needed to provide sufficient energy to maintain liveweight, assuming the sheep are neither pregnant nor lactating. Adjustments for pregnancy and lactation are discussed in the next section.

To calculate the maintenance feed requirement you must know the energy content of the ration to be used. Appendix 1 is a guide to the energy contained in various feeds. Feeds will vary dramatically in both energy and protein and the values contained in Appendix 1 are average values only. Whenever possible, a feed analysis is recommended so that rations can be calculated accurately.

Once the energy content of the feed is known, use Figure 4 to predict the amount of feed needed to meet maintenance requirements. If several feeds are being fed concurrently the following procedure is used to calculate the energy content of the mixed ration. Use the M/D of the mix to calculate rates from Figure 4.

For example a ration containing 80% wheat (13 M/D) and 20% clover hay (9 M/D). The calculation is as follows:

$$\frac{(80 \times 13) + (20 \times 9)}{100} = 12.2 \text{ M/D}$$

Find the appropriate value for 'shorn empty liveweight (kg)' for your sheep and place a ruler intersecting this liveweight and 12.2 on the Feed M/D line. The point where the ruler cuts the right hand line indicates how much dry matter needs to be fed to maintain liveweight. For a 45kg sheep and 12.2 M/D the feeding rate is 500g/hd/day of dry matter.

All feeds contain some water. Hay and grain are typically 90% dry matter so to determine the quantity of the ration 'as fed', multiply the dry matter feeding rate by 100 and divide by the dry matter percentage.

For example:

$$\frac{500 \times 100}{90} = 555 \text{ g/h/d of the mix}$$

Note that as the energy value of feeds declines below about 7.5 M/D, it is likely that a dry sheep will be unable to consume sufficient quantities to achieve maintenance. For pregnant and lactating ewes a feed below 9.5 and 11 M/D respectively is unlikely to be sufficient.

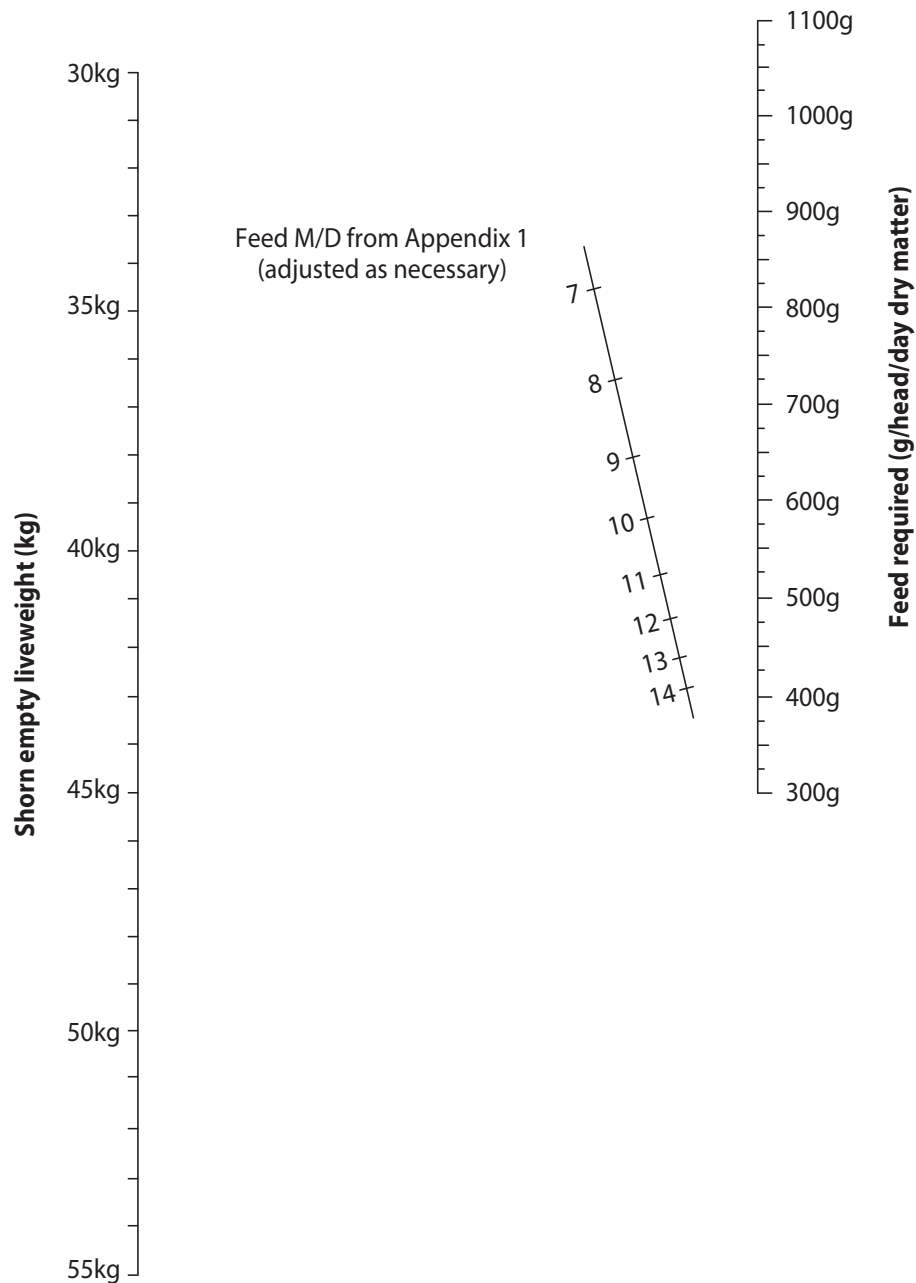


Figure 4. Daily feed (dry matter) required for maintenance of sheep

Note - following calculation of the feed required to meet energy needs for maintenance, the additional feed needed for pregnancy or lactation can be calculated using Table 23.

Table 23. Allowances for pregnancy and lactation

	Factor	Minimum* crude protein %
Dry ewe or wether	1.0	6
Ewe flock to last month of pregnancy	1.0	6
Ewe flock during the last month of pregnancy	1.7**	8
Ewe flock – first month of lactation	2.5	12
Ewe flock – second and third months of lactation	1.8	12

* These minimum values are shown as a guide for maintenance feeding in circumstances where feeding costs need to be minimised. For any diet, but especially one based on grain, crude protein must be adequate (see Table 25).

** Feeding levels should be gradually increased to this allowance from 6 weeks before lambing.

Energy requirement for pregnancy and lactation

Once the feed requirements for a dry sheep have been calculated, allowances can be made for the increased requirements for pregnancy and lactation by multiplying the maintenance requirement by the appropriate factor in Table 23.

The requirements in Table 23 for late pregnancy and lactation are average requirements and assume a flock consisting of both single-bearing (70–80%) and twin-bearing (20–30%) ewes. Individual ewe requirements vary around this average. For example, ewes at the peak of lactation rearing twins need about 3.3 times maintenance but within a flock, ewes vary in their stage of pregnancy and lactation and the factors in Table 23 are the best indication of flock needs.

Table 24. Maintenance feed requirements ('as fed') for full hand feeding of sheep

Feed options: Minimum weight (kg) per day 'as fed'						
Stock type	Grain only (12ME)	Hay only (8.5ME)	50:50 Grain: Hay	80:20 Grain: Hay	Silage (35% dry matter 9ME)	Expected weight gain/day
Weaner (20kg)	0.62	1.08	0.80	0.68	2.54	0.1kg
Weaner (30kg)	0.76	1.32	0.98	0.84	3.09	0.1kg
Adult dry stock (50kg)	0.65	0.99	0.79	0.7	2.37	Nil
Ewes, Last 6 weeks of pregnancy (50kg)	1.1	1.68	1.33	1.18	4.02	Nil
Ewe and Lamb to one month (50kg)	Not Suitable	2.46	1.96	1.74	5.91	Nil
Ewe and Lamb to 2 or 3 months (50kg)	Not Suitable	1.77	1.41	1.25	4.26	Nil

Table 25. Predicted feed and minimum protein requirements for merino weaners

Weaner Liveweight											
		10kg		15kg		20kg		25kg		30kg+	
Growth target	M/D	Feed g/d	Protein %	Feed g/d	Protein %	Feed g/d	Protein %	Feed g/d	Protein %	Feed g/d	Protein g/d
Maintain weight	8	Feeding to maintain weaners below 20kg is not recommended				510	8.7	590	8.7	680	8.7
	9					440	9.5	510	9.5	590	9.5
	10					380	10.0	450	10.0	510	10.0
	11					340	10.8	400	10.8	450	10.8
	12					300	11.5	350	11.5	400	11.5
	13					270	12.5	320	12.5	360	12.5
50 g/d	10	350	14.5	450	13.0	560	11.8	610	11.1	770	10.4
	11	300	16.3	400	14.0	490	12.9	580	12.0	660	11.6
	12	260	18.7	350	15.4	430	14.0	510	13.0	580	12.5
	13	240	19.5	310	16.7	380	15.2	450	14.1	510	13.6
100 g/d	11	420	17.9	540	15.1	660	13.5	780	12.3	880	11.7
	12	360	20.2	460	17.0	570	14.9	670	13.6	760	12.8
	13	330	22.4	410	18.4	500	16.3	590	14.7	670	13.8
150 g/d	12	470	20.5	590	17.5	710	15.5	840	13.8	950	11.8
	13	420	23.4	510	19.5	620	16.9	730	15.1	830	13.9

Energy requirements for weaners

Energy and protein are important to achieve adequate performance from weaned lambs.

Table 25 predicts the daily amount of feed of a specific M/D required to achieve a given growth rate in merino weaners. The minimum crude protein requirement for each situation is also shown.

The rate required varies according to the M/D of the feed, the current weight of the lamb and the required weight gain.

Example: for a 15kg weaner to achieve 100g/ hd/day weight gain on a ration with 12 M/D the required feeding rate will be 460 g/hd/day at a minimum crude protein requirement of 17%. If a feed M/D is not shown in the table it means that feed of that energy concentration would be unsuitable for the intended liveweight and weight gain. This is because weaners of that weight would reach their intake limit before sufficient ME is consumed to achieve that growth rate target.

Young weaners also need roughage as part of their diet to encourage continued rumen development. This should comprise at least 20% of the total ration, and preferably be a high-quality legume hay.

Energy allowance for chill

Chill (the combination of wind, low temperatures or rain, or both) can significantly increase the energy requirements of sheep. For example, freshly shorn sheep will need at least double the calculated feed requirements if wind conditions approach 15km/h and daily minimum and maximum temperatures are in the range of 0–10°C.

The same sheep, in calm conditions experiencing similar temperatures, require only 60% more than the calculated feed requirement.

For sheep off-shears, 20% more feed will be a minimum requirement even in relatively mild conditions. Chill can significantly influence energy requirements until fleece length exceeds 3 cm.

Good-quality hay is the best source of extra feed during cold stress periods as there is no risk of grain poisoning from increased feeding rates and digestion occurs over a longer time frame, which raises the body temperature for longer. Ad lib feeding is necessary to achieve maximum intake.

Lupins are the only grain that can be fed at rapidly increased quantities without risk of acidosis (grain poisoning).

Protein

Rapidly growing sheep or lambs, and ewes in late pregnancy and through lactation, have greater needs for protein than do animals just maintaining weight. The amount of protein required must also balance the energy content of the diet if rumen fermentation is to have the greatest efficiency.

Much of the protein in feed is reduced to ammonia in the rumen. Ammonia is then used as a nitrogen source by rumen microbes to construct new protein. It is the flow of microbial protein to the true stomach and intestine that provides the majority of digestible protein to ruminant animals.

Table 23 lists the minimum crude protein requirements for various classes of mature sheep. Table 25 lists the requirements for weaners. Appendix 1 shows average protein levels for various types of feeds.

If more than one feed is being fed the following procedure is used to calculate the protein content of the mixed ration.

For example, a ration containing 80% wheat (14% protein) and 20% lucerne hay (16% protein). The calculation is as follows:

$$\frac{(80 \times 14) + (20 \times 16)}{100} = 14.4\% \text{ protein}$$

Although Table 23 indicates relatively low minimum protein requirements for various types of sheep, it may be financially viable to use feeds with a better balance between energy and protein. To do this, you may need to increase the protein proportion of some diets according to the suggested protein contents in Table 26.

Oat grain is a common feed that is often unbalanced for protein. Oat grain can often be at least 11 M/D but only 8% crude protein (CP). Referring to Table 26 it is clear that this oats would need to be 14% CP to be balanced. Some other source of protein or nitrogen could be mixed with the oats to raise the CP of the diet. Lupins are often fed with oats for this purpose.

The benefits of balancing the protein in the ration would come from either increased productivity from the same amount fed, or feeding less for the same level of productivity. For maintenance feeding, the required rate may only be reduced by 10% so the financial viability of adding another source of protein to the grain will depend on the relative cost of feeds (particularly protein-rich feeds). If high levels of production are expected (e.g. finishing lambs), the viability of adding extra protein is likely to be better due to the higher value the product. Each circumstance needs to be evaluated on its individual merit.

Table 26. Crude protein required to maintain a balance between energy and protein

Energy content of diet (M/D)	Crude protein requirement* (%)
13	16
12	15
11	14
10	13
9	11.5
8	10
7	9

* Assumes 70 percent rumen degradability.

Urea as a protein supplement

Urea, while not a protein, will form ammonia for use by rumen micro-organisms. Adding 1% of urea by ration weight to the diet will increase the overall crude protein by 2.6%.

Warning: urea is toxic if fed at too high a rate.

Sheep should receive a maximum of 3g of urea per 10kg of liveweight. The percentage added to the ration will be determined by the intended feeding rate. A dry sheep of 50kg may only need 500g of feed per day and can safely consume up to 15g of urea. This equates to 15g in 500g or 3%. A 25kg weaner can only consume 7.5g of urea per day and if eating 800g of feed per day the appropriate maximum urea concentration would be only 1%. If allowed ad lib access that same weaner may eat up to 1200g per day and the safe urea rate would be limited to around 0.6%.

Urea concentrations above 2% are likely to depress diet intake. Urea supplementation will only be effective if:

- » there is a good supply of energy but protein is limiting
- » sheep are fed daily or through self-feeders.

Urea is toxic, so it is important that it be properly mixed into the feed, as concentrated pockets of urea will kill stock. The preferred method of mixing urea with feed is to dissolve it in hot water and spray the solution onto grain when augering or filling the feed bin. The rate will depend on the concentration of the solution and the speed and size of the auger.

Minerals

Six major minerals and seven minor minerals are important to sheep production. However, only two – calcium and sodium – are needed as extra supplements during drought feeding. Calcium is deficient when diets consist mainly of cereal grain. To prevent calcium deficiency, add 1.5% by weight of ration of finely ground agricultural limestone (calcium carbonate) to cereal grain. For every 100 kg of grain, add 1.5 kg of limestone. Do not use builders lime, burnt lime or slaked lime.

Spread lime onto grain when filling the feed-out bin. Lime is not lost when feeding-out as the fine particles stick to the grain.

Sodium is also deficient in most grains. Add 0.5% of fine salt to grain diets to prevent a deficiency.

Water can often be a source of sodium. More salt is not needed if the water has high salt levels. The likelihood of any other mineral being deficient is low.

Vitamins

Vitamin A and E are the only vitamins likely to be deficient as a direct result of drought feeding. Vitamin A is obtained from green pasture, hay with good green colour, and yellow maize. Even a short green pick will supply adequate quantities of the vitamin. Vitamin A is stored in the liver. Young sheep usually experience deficiencies when they have been without green pasture, green hay or yellow maize for six months, and adults will be deficient after 12 months. Symptoms are night blindness, eye discharges and ill-thrift.

There is a relationship between vitamin E and selenium. Grains and hays are fair to good sources of vitamin E, although there is considerable variation.

A vitamin E deficiency induces symptoms similar to selenium deficiency (that is, still-born lambs, and older lambs that suffer from a stiff, stilted gait, lameness and arch back). If you suspect a deficiency, seek veterinary advice for confirmation and dose rates.

The best solution is to administer a Vitamin A,D,E injection that will alleviate the problems for some months.

Full hand feeding of sheep – feeding management

Grain introduction

When introducing sheep to grain and pelleted diets, there is a significant risk of grain poisoning or acidosis. It is the high starch content of most grains that causes the problem. Lupins, which are low in starch, are the exception and are useful when animals need immediate introduction to a high-energy diet.

Slowly introduce sheep to high-grain diets according to the schedule shown below in Table 27. It is useful to use hay in addition to the recommended rate of grain to get animals eating. The amount of hay can be reduced to nil over the introduction period.

Note: If sheep show symptoms of grain poisoning, return to the next lowest level of feeding for two to three days and treat individual animals for grain poisoning. Adding 2% sodium bentonite or 1% salt to grain rations helps to reduce the risk of poisoning during grain introduction.

Table 27. Grain introductory program

Days	Amount of grain grams per head	Frequency of feeding
1 and 2	50	Daily
3 and 4	100	Daily
5 and 6	200	Daily
7 and 8	300	Daily
9, 10 and 11	370	Daily
12, 13 and 14	430	Daily
15 and 17	860	Every 2nd day
19, 22 and thereafter	1290	Every 3rd day

Changing grains, nuts or pellets

Sheep that are accustomed to one type of grain can not immediately adjust to another. A sudden switch in feeds can result in deaths and a high incidence of tender wool. Even the same grain type obtained from a different source can cause losses.

Manufactured feeds can also cause grain poisoning as the manufacturer may change the major grain ingredients, or change the processing procedure from one batch to the next. If it is necessary to use a different grain, arrange the supplies early and mix the old grain with the new, gradually increasing the concentration of the new grain over at least four feeds.

Incorporate sodium bentonite or salt (as outlined above) to reduce the risk of grain poisoning during the change.

Frequency of feeding

Frequency of feeding is determined by the physiological state of the sheep, type of feed, availability, the capacity of troughs and self-feeders, and also the risk of feed losses through rain, birds and other animals. Feed dry sheep, and ewes up to the last four weeks of pregnancy, twice weekly as it gives better results than more regular feeding. However, ewes in late pregnancy or during lactation and young weaners require daily feeding or a constant supply of feed from self-feeders. These sheep are commonly fed both hay and grain on alternate days.

Feeding methods

Grains are normally fed by trailing on the ground, particularly the larger grains (for example, corn), which are easily picked up by sheep. Trailing is not advisable when the ground is cracked or excessively dusty. Troughing is necessary.

Low-cost troughs can be made from surplus farm materials including corrugated iron between steel posts, timber or rubber belting. If using salvaged industrial materials ensure that there is no risk from chemical residues.

It is advisable to feed meals and fine materials in troughs. Trail length and trough space depend on the size and number of sheep, and the amount of ration being fed out. If you are using small daily feeds, allow up to 15 cm of double-sided trough for large-framed sheep; with less frequent feeding, trough lengths can be reduced to 7 cm.

Feed lambs and weaners from troughs with hay placed in hay racks. When feeding hay on the ground, break bales open and scatter them widely to allow ready access. Rolling out round bales will improve accessibility.

Ration processing

Hammermilling, cracking or soaking grain is not necessary for sheep. All sheep, including young weaners, can digest whole grain without wastage. Hammermilling increases the risk of grain acidosis if animals are likely to gorge.

There is no advantage in processing hay.

Feeding paddocks and lots

In drought, sheep should be restricted to very small areas or even feed lots. This limits pasture damage and erosion, restricts possible weed contamination derived from purchased fodders, leads to more efficient fodder usage, and reduces costs associated with feeding.

In addition, when the drought breaks, restricting sheep movements will help prevent scouring due to animals chasing the first green pick.

Refer to the *NSW DPI Primefact 554 Confinement feeding stock*.

Water requirements for sheep and cattle

Water is an essential nutrient for all animals. It is important for both animal welfare and business profitability that sheep and cattle have an adequate supply of good quality water. The amount and quality of water required varies between species of livestock, between classes of stock within the species, and in response to the environment in which the stock are running (see Table 28 and Table 29).

The suitability of water for stock use is determined by the following factors:

- » water quality, which includes salinity, acidity, toxic elements and compounds, and algal growth
- » environmental factors such as air temperature and feed quality
- » animal factors including breed differences and age and condition of stock.

Water quality

Quality of water is broadly defined as its fitness for consumption by livestock to maintain satisfactory production. The principal factors affecting water quality are as follows.

Salinity

The main factor that determines the suitability of water for stock is the proportion of dissolved salts in the water. Dissolved salts in water are expressed in milligrams per litre (equivalent to parts per million – ppm) or in terms of the electrical conductivity of the water, measured in decisiemens per metre (dS/m) or microsiemens per centimetre (µS/cm).

Maximum advisable levels are shown in Table 29.

(1 dS/m = 1000 µS/cm = approx. 640 mg/L or 640ppm.)

Table 28. Average water requirements of stock

Stock type	Consumption Per head per day (L)
Sheep	
» Weaners	2–4
Adult dry sheep	
» grassland	2–6
» saltbush	4–12
Ewes with lambs	4–10
Cattle – Lactating cows	
» grassland	40–100
» saltbush	70–140
Young stock	25–50
Dry stock (400kg)	35–80
Horses	40–50

Notes

- » Figures quoted for consumption have a wide range; this variation is explained in the text.
- » When planning water supply requirements, allow for evaporation losses and consumption by native and feral animals.

Table 29. Tolerances of livestock to total dissolved solids (salinity) in drinking water (mg/L)

Stock	Desirable maximum concentration for healthy growth	Maximum concentration at which good condition might be expected*	Maximum concentration that may be safe for limited periods*
Sheep	5,000	5,000–10,000	10,000–13,000
Beef cattle	4,000	4,000–5,000	5,000–10,000
Dairy cattle	2,500	2,500–4,000	4,000–7,000
Horses	4,000	4,000–6,000	6,000–7,000
Pigs	4,000	4,000–6,000	6,000–8,000
Poultry	2,000	2,000–3,000	3,000–4,000

* The level depends on the type of feed.

Adapted from *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000*.

Generally, surface waters are low in salts compared with artesian or underground water. Many factors influence the concentration of salts that animals can tolerate in their drinking water. Salinity increases the intake of water by animals, partly through the taste and partly to allow greater water turnover so that the body can regulate the salt balance.

Acidity or alkalinity (pH)

Water with a pH value below 6.5 (acid) or above (alkaline) can cause digestive upsets in stock, resulting in rejection of the water, depressed appetite and consequent loss of production. If this problem is present, animals may perish, even when it appears they have adequate water.

Adding alum can correct high pH, but this should be done with care as alum is highly acidic. Water with a pH below 6.5 can be treated by adding lime.

Toxic elements and compounds

Water is a potential source of important minerals and other compounds. However, the concentration of these substances can reach toxic levels, particularly in underground water.

If present in high enough concentrations, iron, magnesium, arsenic, lead, mercury, selenium and fluorides can lower livestock productivity. If productivity losses are suspected, a veterinarian or livestock adviser can investigate the problem by examining the affected stock and conducting a detailed water analysis.

Algae growth or bloom

Algae occur naturally in both fresh and brackish waters. They respond to sunlight and fertilisers, and when environmental conditions are right, algal growth can make water unpalatable to stock.

An algal bloom is the excessive growth of a particular algal species and is most likely to occur when the water is still, warm, and contains high nutrient levels. All algal blooms can cause water use problems. However of most concern are those caused by blue-green algae as a number of these are toxic.

Currently in NSW, only Coptrol Aquatic Algicide®, Cupricide Algicide® and Cupricide 110 Algicide® are approved for the control of blue-green algae and some other algae types. They must be used in strict accordance with their label conditions and directions. These products are registered for use in farm dams, rice paddies and irrigation conveyance systems. They must not be used in rivers, streams, creeks, wetlands, lakes or billabongs, and water treated with these products must not be allowed to spill into these water bodies.

Environmental factors

Temperature

In hot weather, animals use more water for evaporative cooling. For example, shearing increases the heat load on sheep in summer because the insulation formerly provided by the fleece is lost. The sheep adjust to this heat load by increasing evaporative cooling through panting.

Water consumption can increase by 78 per cent under extreme conditions. Providing shade will largely relieve this situation. In normal conditions with good quality water, consumption in summer will be about 40 per cent higher than in winter. However, with salty water the summer intake may be 50 to 80 per cent higher than consumption in the cooler months.

The amount of water that stock drink also depends on the temperature of the water. Generally, animals prefer water at or below body temperature and avoid warmer water. Cool water is preferred in hot conditions.

Marginal quality water may become unsatisfactory during summer as animals drink more because of high temperatures and drier pasture. The salinity of some water may also increase because of evaporation from troughs, bore drains and shallow tanks.

Drought

During drought, stock require more water as they are forced to select more fibrous and less digestible feed. This extra water is used to maintain the movement of the coarse feed in the gut. As drought worsens and stock become weaker, marginal waters may become unsuitable as the animals' tolerance of the salt decreases.

Feeding salt or salt-based licks or blocks during dry periods increases water intake. If water quality is marginal, this added salt intake may depress appetite and cause digestive upsets – the opposite of the supplement's purpose.

Pasture composition

The diet of stock also influences their water requirement. Good green pasture can supply all of an animal's water needs. Sheep under these conditions may not need to drink for many weeks.

Good pasture allows stock to use water that would normally be unsuitable at higher levels of consumption. Stock on dry pasture need increased water consumption to utilise the less digestible fodder.

In pastoral areas, stock grazing saltbush or other chenopod plants require large volumes of relatively low-salinity water. This is because of the high level of salt in the diet and the need for a high water turnover to maintain the salt balance in the body.

Animal factors

Age and condition of stock

Young animals, heavily pregnant or lactating females, and aged or weakened stock are less tolerant of saline water. In weaner sheep, high salinity depresses growth rate and wool production and causes scouring.

Breed differences

British breed sheep need about 20 per cent more water than Merino sheep in hot weather.

Watering points

Water consumption can be affected by the cleanliness of the watering point. If the water level in an earth tank is low, animals may be forced to wade through mud to get to the water. Due to the boggy surroundings, the water becomes heavily contaminated with suspended soil and faeces, which can lead to stock rejecting the water. Animals in weak condition may become bogged and die.

Feral pigs can create the same effect by wallowing along the water's edge.

Dams with low water levels should be fenced off and the water pumped or gravitated to temporary troughing. This will ensure maximum use of the available water by avoiding fouling and reducing stock losses from bogging.

Troughs used in watering systems should be drained and cleaned regularly. Algal growth in troughs affects taste and odours that can repel stock. Salinity also builds up due to evaporation if troughs are not drained.

The frequency of cleaning mostly depends on the water temperature, which affects the rates of evaporation and algae growth. The type of stock will also have some influence on the frequency of cleaning, as tolerance of contamination varies according to the requirements of the particular class of stock.

Even a slight contamination of trough water causes problems for some stock. Weaner sheep sometimes refuse water with a thin layer of dust on the surface of an otherwise clean trough.

When introducing stock to a new paddock, make sure they are familiar with the location of the watering point and are drinking the water, particularly in pastoral areas. If water quality is marginal or unknown, check newly introduced stock during the first week to ensure that there is no problem.

Watering radius

In pastoral areas, sheep normally graze within a radius of about 2.5km of a watering point, and cattle within a radius of about 5km.

If stock require more water due to lactation, salinity or dry feed, they may need to drink more than once a day. This will reduce their foraging radius and the area of the paddock being used.

Feed quality service

NSW DPI operates a feed quality service in Wagga Wagga that provides a quality assured analytical service with a fast turnaround time. The service uses the latest technology and is fully accredited by NATA.

The service also participates in all proficiency tests conducted by the Australian Fodder Industry Association (AFIA).

Packages and sampling kits

The standard packages and sampling kits are available through any NSW DPI office or by contacting the Wagga Wagga customer service unit.

- » Standard forage package
- » By-products package
- » Premium silage package
- » Grain and mixed feed package

We offer a tailored package including the following tests:

- » Dry matter % (DM)
- » Fat
- » Dry matter digestibility % (DMD)
- » Ash content
- » Crude protein (CP)
- » Organic matter
- » Fibre
- » Silage pH
- » Metabolisable energy (ME)
- » Silage ammonia-nitrogen

More information

For information on custom pricing, turnaround times, collecting samples, submission and reporting procedures, etc., please contact the customer service unit on (02) 6938 1957, or www.dpi.nsw.gov.au/animal-feed-testing

Section 4 Farm management

- » Personal and family wellbeing and financial assistance guide
- » Pasture sustainability and management in drought
- » Productivity after the drought
- » Animal welfare
- » Biosecurity matters
- » Preventing animal health problems during drought
- » Cattle movements and bovine Johne's disease (BJD)
- » Sheep health
- » OJD and sheep movement

As at 1 July 2019, the NSW Government's Emergency Drought Relief Package included:

- the Farm Innovation Fund
- transport subsidies (stock, fodder and water)
- waivers to Local Land Services rates for 2020
- waivers to fixed charges for NSW Water and bore licences
- emergency water carting
- waivers to interest charges for Farm Innovation Fund loans
- mental health support, including rural counsellors
- Farm Business Skills programs
- donated fodder transport
- rural preschool and long day care centre fee subsidies.

NSW DroughtHub

A one-stop online resource is available at www.droughthub.nsw.gov.au to help primary producers, their families and communities to prepare for and manage drought conditions. This provides an up-to-date reference and information about assistance and support available. When new in-drought assistance or packages are announced the DroughtHub will provide the latest information and can connect you to the relevant NSW or Commonwealth agency. For help navigating the NSW DroughtHub, call the NSW Rural Assistance Authority on 1800 678 593 or contact your local Rural Financial Councillor.

Personal and family wellbeing and financial assistance guide

Farming in Australia requires constant management of a wide variety of risks. Natural disasters, disease, pests, market fluctuations and policy changes provide ever-present challenges to business and personal resilience. This is most evident when dealing with drought. Long dry periods extending to severe drought are part of a repetitive climatic cycle where farmers are either managing, recovering from, or preparing for drought conditions. Flexibility and sound risk management strategies are essential for the health and wellbeing of the farm business, its natural assets and the people within it.

In response to the drought cycle, NSW DPI formed the Rural Resilience Program (RRP) in 2014. Adapted from the previous Drought Support and Rural Support Programs that had formed during the millennium drought, the RRP became a permanent program within DPI with a strong focus on preparedness for drought and other adverse events.

Resilience is considered to be a process, where individuals adapt and move forward in a positive direction despite experiencing significant adversity.

Crucial to building and maintaining personal resilience in adverse circumstances is to understand the effects of stress. Stress is cumulative. The more challenges you face, particularly in a short time frame, the more stress is placed on your mental and physical health and your decision making capacity can suffer as a result. It is useful to apply what is known as the CIC (kick) principle (developed from Steven Covey's Seven Habits of Highly Effective People). For each challenge, first decide whether it falls within your circle of Control, Influence or Concern. This determines the appropriate amount of energy to give to responding to and managing it. For example, we can't control or influence drought. It clearly falls within our circle of concern. What we can control is our decision making around management of our stock, land and other resources. This is where our energy is best directed if we are to avoid burn out and becoming overwhelmed which can lead to helplessness and depression. We may also be able to influence policy and drought response at a local community level.

The next important aspect of building resilience and improving decision making is to tap into resources.

Following is a list of resources to support you, your family and your business in your decision making and management of drought and other challenging times.

The NSW DPI RRP has staff across NSW who work closely with partners such as the NSW Rural Assistance Authority, Rural Financial Counsellors, Rural Adversity Mental Health Program (RAMHP) and Local Lands Services to deliver initiatives tailored to the particular needs of the community and provide referral support.

The RRP provides educational, personal, and business resilience building activities and works to achieve an informed and collaborative approach to supporting farmers across various agencies.

The RRP listens to farming communities, learns about their issues and needs and explores what services and opportunities are available. It links farmers with existing services and initiatives and works with community partners to create new initiatives and opportunities.

Visit www.dpi.nsw.gov.au/rrp

NSW DPI Rural Resilience Program

'Listen, learn and link to create opportunities for farming communities'

Rural Resilience Officers and Rural Support Workers provide information on available support for farming families and can connect them to relevant service providers. If you need assistance please contact your nearest Rural Resilience Officer or Rural Support Worker.

To find your local Rural Resilience Officer, refer to www.dpi.nsw.gov.au/about-us/rural-support/RRP

Farm Family Gatherings

There may be opportunities to work with your local Rural Resilience Officer or Rural Support Worker (see above) to have a Farm Family Gathering in your area. These gatherings are an opportunity for financial, production and emotional/physical health providers to share their knowledge and experiences with farming communities. They are also a great opportunity for farmers to share their experiences and the personal impact of adverse events and how they are coping. These gatherings lift the spirits of people when they realise that they are not in this alone.

Support for farmers

Local Land Services

Local Land Services delivers quality, customer-focused services to farmers, landholders and the community across rural and regional NSW. Local Land Services is a statewide organisation offering integrated services, delivered regionally and tailored for each community, industry and landscape.

Local Land Services helps secure the future of agriculture and the environment for NSW communities. The Local Land Services team is on the ground when it matters, with knowledge, networks and experience. Its programs and partnerships grow farm productivity and healthy environments. Its services and partnerships play a vital role in helping to protect against pests, diseases and environmental threats while we connect our customers with the best services, advice and networks. Contact your Local Land Services today on 1300 795 299.

Financial

Rural Financial Counselling Services (RFCS)

The Rural Financial Counselling Service NSW provides free and impartial rural financial counselling to eligible primary producers, fishers and small rural businesses that are suffering financial hardship.

To contact your nearest Rural Financial Counsellor visit www.raa.nsw.gov.au/rfc or phone:

Northern region 02 6662 5055

Southern region 02 6452 5850

Central region 1800 940 404

Farm Household Support

The Federal Government Department of Human Services provides help for farmers and their families experiencing financial hardship. To be eligible you must:

- » be a farmer or the partner of a farmer. If you are the farmer you must contribute a significant part of your labour and capital to the farm enterprise based on specific criteria
- » meet an income and assets test
- » be willing to undertake a Farm Financial Assessment
- » be willing to enter into a Financial Improvement Agreement to help you improve your financial circumstances

More information: Farmers Assistance Line on 132 316 or visit www.humanservices.gov.au/individuals/services/centrelink/farm-household-allowance

Office of the Small Business Commissioner

Small Biz Connect is a personalised and highly subsidised business advisory program for small businesses in NSW including agribusinesses.

More information: phone 1300 134 359 to find your nearest adviser and make an appointment.

The NSW Rural Assistance Authority

The Rural Assistance Authority administers a range of assistance schemes, including

- » the Farm Innovation Fund
- » Emergency Water Infrastructure Rebate
- » transport subsidies (stock, fodder and water)
- » waivers to interest charges for Farm Innovation Fund loans
- » Farm Business Skills programs
- » donated fodder transport
- » farm debt mediation.

For more information phone 1800 678 593 or visit <https://www.raa.nsw.gov.au>

Regional Investment Corporation

Commonwealth loans

The Australian Government offers two types of loans to farm businesses - farm investment loans and drought loans. For information about the loans and eligibility requirements please contact the RIC on 1800 875 675 or visit www.ric.gov.au

If you have an existing Commonwealth Concessional loan, the NSW Rural Assistance Authority will continue to administer this loan.

More information: phone 1800 678 593.

Australian Tax Office (ATO)

Profit from forced disposal or death of livestock

You can elect to spread profit earned from the forced disposal or death of livestock over a period of five years.

Alternatively, you can elect to defer the profit and use it to reduce the cost of replacement livestock in the disposal year or any of the next five income years. Any unused part of the profit is included in assessable income in the fifth income year.

If you are forced to shear your sheep a second time in the same financial year there may be an opportunity to carry forward the income from the second shearing.

You can elect to spread or defer profits if you dispose of stock or stock dies because:

- » land is compulsorily acquired or resumed under an Act
- » a state or territory leases land for a cattle tick eradication campaign
- » pasture or fodder is destroyed by fire, drought or flood and you will use the proceeds of the disposal or death mainly to buy replacement stock or maintain breeding stock to replace the livestock
- » they are compulsorily destroyed under an Australian law for the control of a disease (including bovine tuberculosis) or they die of such a disease
- » you receive official notification under an Australian law dealing with contamination of property

For more information on this contact the ATO or your accountant.

Financial Hardships Tax Provisions

The Australian Tax Office has a range of options for farmers experiencing financial hardship such as deferred payment plans.

More information can be found via <https://www.ato.gov.au/General/Financial-hardship> or 13 72 86

NSW Farmers Association

The NSW Farmers Association is a membership organisation representing farmers across NSW. The NSW Farmers advocates on behalf of the NSW industry on key issues that affect farming businesses including biosecurity, farm trespass, animal welfare, imports and product labelling. The committee is made up of farmers from across the state that work to ensure the views of NSW farmers are heard at the state and national level.

More information: Phone 9478 1000 or visit www.nswfarmers.org.au

NSW Farmers Drought Network

The NSW Farmers' Drought Network has launched a page to provide service information, links to assistance and services to individuals and families conducting, directly or indirectly, primary production businesses that are being impacted by drought conditions in NSW.

For further information visit http://www.nswfarmers.org.au/NSWFA/Content/IndustryPolicy/Resource/Drought_Network.aspx

Australian Pork Limited

Australian Pork Limited (APL) is a rural industry service body for the Australian pork industry. It is a producer-owned company delivering integrated services that enhance the viability of Australia's pig producers. The organisation aims to enhance opportunities for the sustainable growth of the Australian pork industry by delivering integrated marketing, innovation and policy services along the pork industry supply chain. APL pursues opportunities for the industry at both the domestic and international level.

More information: Phone 1800 789 099 or visit www.australianpork.com.au

NSW DPI Feed Quality Service

Feed testing is an integral part of good animal nutritional management to achieve the best and most profitable results.

The Feed Quality Service (FQS) is unique in Australia; it is the only feed testing laboratory that integrates feeds evaluation, ruminant nutrition, and pasture and crop research with commercial feed testing and has links with development officers to package research and related information generated by the service.

FQS provides a range of analytical services to internal research programs, external research and commercial organisations, and private individuals (farmers) using both wet chemistry methods and Near Infrared (NIR) Spectroscopy

FQS also reports calculated feed quality parameters including Metabolisable Energy (ME; ruminants), Apparent Metabolisable Energy (AME; poultry) and Digestible Energy (DE; pigs, horses & fish) (Appendix 1).

More information: Contact 1800 675 623 or wagga.csu@dpi.nsw.gov.au

Dairy Australia

Dairy Australia has a webpage with activities, resources and tools to assist dairy farmers.

More information

Contact Dairy Australia on 1800 270 778 or visit:

Dairy NSW www.dairyaustralia.com.au/dairynsw

Murray Dairy www.murraydairy.com.au

Sub-tropical www.dairyaustralia.com.au/about-dairy-australia/dairy-regions/subtropical

Health and wellbeing

Mental Health and Wellbeing

The Rural Adversity Mental Health Program (RAMHP)

The RAMHP provides information services to individuals, communities and service providers to link rural and remote people to the help they need. This includes information on where to access services, common mental illnesses and how to keep mentally healthy, as well as the Glove Box Guide to Mental Health. To find the location of your nearest RAMHP Officer go to www.ramhp.com.au or call 02 6363 8444 and they will advise you where your nearest counsellor is.

Kids Helpline

Phone 1800 551 800 telephone counselling service 24 hours, seven days a week.

NSW Mental Health Line

Phone 1800 011 511

Mensline Australia

Phone 1300 789 978. 24 hours a day, 7 day telephone counselling for men.

Beyondblue

Depression information phone 1300 224 636

Lifeline

131114

Black Dog Institute

phone 9382 4530

Australian Red Cross

The Australian Red Cross provides personal support during a disaster and an outreach service to affected households. Contact 1800 660 066 or visit www.redcross.org.au

The Salvation Army

The Salvation Army is supporting farmers and communities affected by drought. Phone 8757 8088 or visit www.salvos.org.au

The Country Womens Association

The CWA is the largest women's organisation in Australia and aims to improve conditions for country women and children. Phone 8337 0200 or visit www.cwaofnsw.org.au

Pasture sustainability and management in drought

Introduction

In general, pastures are quite resilient, and have valuable defense mechanisms to enhance survival through adverse periods. In most situations well-adapted perennial pastures are preferred as they can maintain ground cover, which reduces the risk of erosion and weed incursion. Perennial pastures are also able to respond and grow quickly from an established base when it rains.

Many annuals are adapted for survival after droughts through high soil seed reserves and because of favourable seed characteristics such as hard seedcoats.

Causes of stress on pastures

Dry conditions are not the single cause of stress on pastures. The following factors can also contribute to the death of plants especially perennials:

- » inappropriate grazing management
- » poor general pasture health due to previous disease or insect attack
- » soil nutritional factors
- » depth of soil and root depth.

A well-managed pasture that is adapted to the soil, climate and livestock system is more likely to survive drought than a pasture that is poorly matched to the environment, is inappropriately managed, and is already under stress as drought conditions set in.

Factors that need to be considered

Pasture characteristics

- » In many situations, native species are more resilient than introduced species, and may better survive drought conditions.
- » Paddocks will vary in their value to the livestock enterprise both during and after the drought. An assessment of a paddock's value is essential to make decisions in a deepening drought.
- » If surviving pastures are compromised, they must be allowed to recover otherwise they may further decline or die.

Cost and management

Perennials are generally more expensive to replace than annuals.

Replacing with native perennials may be expensive and impractical in many cases because of lack of seed and agronomic guidelines on establishment.

Decisions on the management of pasture paddocks should consider the recovery period after the drought breaks.

Pasture re-establishment costs are high and the pasture may be out of production for a significant period.

Extra costs often associated with drought are due to increased erosion risk because of grazing intensity and the death of pasture plants, increased weed invasion because of introduced seed, and reduced competitiveness of the pasture.

Useful pasture management strategies

Plan to reduce the impact of drought

Sowing well-adapted pasture species such as persistent perennial plants and managing the pasture to enhance production and persistence will help to reduce the impact of drought. It will improve pasture production for each millimetre of rain and will allow pastures to carry feed further into a drought and to recover faster when the drought is over.

Lock up the most valuable paddocks if pasture survival is threatened

As dry conditions worsen, it is time to assess each paddock for its pasture composition value, pasture condition, cost of resowing, and its ability to be a productive paddock when the drought breaks. Some (or many) paddocks will need to be locked up, while other paddocks will need to have their stocking rates reduced.

When assessing paddocks consider the following benchmarks:

- » Pasture quantity. Recent research on perennial grass pastures on the Northern Tablelands indicates that the risk of pasture death greatly increases in dry conditions when the pasture is grazed below about 1000kg DM/ ha (kilograms of dry matter per hectare). This benchmark should apply at all times, not only during dry times.
- » Ground cover. Paddock lock-up is also determined by the minimum ground cover level required to prevent erosion. The appropriate ground cover level depends on the slope, the likely rainfall intensity, and the soil type. Some examples of approximate minimum ground cover percentage are:
 - » 70% on red soils in gently undulating country on the northern slopes of NSW
 - » 40% in the semi-arid rangelands in western NSW
 - » 85–90% on the North Coast of NSW.

Sacrifice paddocks

Consider using one or more paddocks, or fencing off parts of paddocks, for use as feeding-out areas.

Refer to *NSW DPI Primefact 554 Confinement feeding stock*

Pastures in semi-arid rangelands

In the semi-arid rangelands and similar low-rainfall areas in western NSW, consider the pasture management guidelines for encouraging a high persistence of rangelands species.

Rangeland pasture management guidelines:

- » Under drought conditions, desirable perennial grasses are at increasing risk if more than about 30% of growth is removed before the next growth opportunity.
- » The risk of loss also increases the longer the grasses are subjected to high use levels.
- » If under dry conditions, usage rises above 30%, paddocks need to be monitored closely so that timely decisions can be made on reducing stocking rates or closing up paddocks. This is particularly important where paddocks have been heavily used in the previous year.
- » Care is required to ensure that ground cover is not reduced below 40%, as soil loss by water or wind erosion can increase rapidly when ground cover is below this level.

Productivity after the drought

While surviving the drought is obviously foremost in your mind, how you care for your natural resources during the drought will determine how productive your property will be for decades to come.

Farm management during a drought is all about making a smooth transition from drought to 'normality' and having the farm in a condition to respond favourably to drought-breaking conditions.

Many properties experience their heaviest losses immediately after drought-breaking rain. Prolonged wet conditions turn animals off their feed. Problems exist under these circumstances if grain is being fed on the ground. As soon as the first green pick emerges, stock may chase this, expending more energy.

It is essential that stock are kept confined to feeding areas until adequate pasture is available. At that point, allow increased grazing time each day until full grazing is provided after six to seven days. Allowing immediate full grazing will lead to digestive disorders.

Weeds recover faster than desirable species after a drought. Observe how the pasture is recovering and decide on a management strategy if weeds show signs of dominating.

Farm planning

A whole farm plan that identifies the various land types, tree lots, soil problem areas, waterways and pasture history will help to locate the most sensitive and the most forgiving areas under drought management practices.

This will include identifying areas:

- » to be protected from stock
- » where stock can be fed
- » that need more fencing or watering points
- » areas that are a priority for pest control, including unwanted grazing by native animals.

By protecting quick-recovery areas, waterways and soil structure, the farm will be in better shape when the rain falls. Maintaining groundcover wherever possible will protect the soil surface and allow more water into the soil where it will be stored for use when plants begin to grow, giving them a better chance of survival. It will also protect seeds and small seedlings, which are the real investment for future recovery.

Soils

The soil resource is critical for the ongoing profitability of the farm. Heavy grazing by stock or feral or native animals can leave the soil vulnerable to wind or water erosion. Organic matter and finer components are lost first, which greatly reduces soil fertility and structure.

Do not leave stock in a paddock until all protection (dead and alive) is removed from the soil. Select paddocks for drought feeding that have a soil type and topography that will be less liable to erosion.

Special consideration needs to be given to areas close to watering or feeding locations. Where possible, and considering issues with weed management from feeding imported fodder, these areas should be rotated so that excessive damage does not occur in any one area. Where damage is unavoidable, an area that is sacrificed may minimise restoration works after the drought.

Stock tracks down slopes can be a starting point for gully erosion. Ripping across the slope can reduce soil loss, but be careful to avoid creating fine soil particles.

Farm dams

When the drought breaks, the initial rains will erode bare soil. Ensure that farm dams are protected so that they do not fill up with silt; if possible, maintain vegetated filter strips. Do NOT feed stock in the immediate catchment of farm dams as the disturbed soil and manure will run into the dam after rain.

During the dry conditions, clean out farm dams, build silt traps above the dams, and ensure that runoff is slow, well directed and conserved. Erosion after a drought can be severe.

Weeds

Weeds introduced in drought feed can become an ongoing liability for a farm. A sound biosecurity plan is the best way to manage this risk and includes the following strategies:

- » Try to find out the source of grain or fodder so that potential problems can be anticipated.
- » Restrict the area over which imported grain or fodder is fed out and keep a record of the area.
- » After the drought breaks, observe the area periodically for the next few years, note any new plants and have them identified.
- » Fodder and grain can also contain herbicide-resistant weed seeds such as annual ryegrass (although this is not a concern for grazing only properties).

Feral and pest animals

During a drought, predatory animals such as foxes and wild dogs may prey on more species if their normal source of food is less available. This can increase impacts on stock and native animals. The decline in ground cover and shrubs can also increase exposure of small native animals and birds to predators. The control of predatory pest animals during a drought is desirable.

Control of pest grazing animals such as rabbits and goats during droughts can reduce competition for limited feed supplies for commercial stock and wildlife. Goats are a particular problem since they 'hang on' longer than other animals and can cause long-term damage to trees and shrubs.

On the other hand, drought conditions may make feral and pest animals easier to control, which will be an ongoing benefit when conditions improve.

Native animals and flora during droughts

Biodiversity underpins the functioning of the whole ecosystem and is particularly important as a component of integrated pest management. Because agriculture is a major user of land in NSW, much of the biodiversity in NSW resides on agricultural properties. During a drought, landowners focus on preserving sufficient stock and resources so that their business can recover after the drought, which means native animals and flora are sometimes not a priority. Considering biodiversity during droughts shows that farmers are committed to responsible stewardship of the land.

Good stewardship of the land maintains its ecological values, maintains amenity for local communities and promotes tourism opportunities. Conservation areas and areas with threatened species or communities should not be grazing during droughts or at other times.

Native grazing animals such as kangaroos contribute to total grazing pressure. If the total grazing pressure significantly exceeds feed availability, then considerable numbers of native animals may die in the latter stages of a drought. It may be in the best interests of native animals, as well as domestic stock, to adjust total grazing pressure earlier in a drought. Contact the National Parks and Wildlife Service for advice.

Native animals also require access to watering points, so the location of these points can influence the distribution of animals and birds. Water points that are heavily used by stock may inhibit their use by native animals so where possible provide alternative water points.

Animal welfare

Be prepared in a drought

The management of livestock, stocking rates and nutrition are linked to animal health and welfare. In Australia, drought is part of the expected management cycle, and all producers should plan in advance for seasonal fluctuations and times when feed and water will run short. Ensure that plans are already in place for adjusting stocking rates and/or supplementing livestock.

The welfare of animals is always important, and in drought, particular attention must be paid to protecting their welfare. Tough decisions will have to be made, and producers with drought-affected stock will need to consider the effects of any intended actions on their animals. Any decision made must be humane and reasonable.

Act early

Delaying action may seem logical but delays usually reduce the number of choices available. You must act early while stock are still fit and strong.

If considering destocking everyone involved in the transportation process, from assembling livestock to handling them at their final destination must adhere to the Prevention of Cruelty to Animals (Land Transport of Livestock) Standards No2. For more information on whether animals are fit to load onto a truck, please visit www.dpi.nsw.gov.au/livestocktransport and download MLA's 'Is It fit to load guide'. Please also refer to *Welfare scoring nutritionally deprived beef cattle, dairy cattle and their crosses, sheep and horses*, published by the Department of Primary Industries - https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0012/449796/welfare-scoring-nutritionally-deprived-cattle-sheep-horses.pdf

Relieve animal suffering

If the situation has deteriorated to the point where stock are suffering, you must immediately feed or agist stock, or send stock to a processor. Sometimes stock may need to be humanely destroyed. It is not an option to just let nature take its course.

Australian Animal Welfare Standards and Guidelines

There are national animal welfare standards and guidelines for some livestock species. The Land Transport Standards and Guidelines are mandated in NSW as the Prevention of Cruelty to Animals (Land Transport of Livestock) Standards 2013 (see below)

The Standards and Guidelines for cattle and sheep are not mandatory in NSW but are referenced under the *Prevention of Cruelty to Animals Act 1979* and may be used in evidence in court proceedings. Sheep standards are found at <http://www.animalwelfarestandards.net.au/files/2011/01/Sheep-Standards-and-Guidelines-for-Endorsed-Jan-2016-061017.pdf> and cattle standards at http://www.animalwelfarestandards.net.au/files/2011/01/Cattle-Standards-and-Guidelines-Endorsed-Jan-2016-061017_.pdf.

Standards and guidelines for the welfare of livestock at saleyards and depots are not legislated. They should be used as a guide and are found at <http://www.animalwelfarestandards.net.au/livestock-at-saleyards-and-depots/>.

Animal Health Australia (AHA) and the Goat Industry Council of Australia (GICA) have developed the Australian Industry Standards and Guidelines for Goats. The proposed standards will replace the Model Code of Practice for the Welfare of Animals: Goats and will be the basis for developing consistent goat welfare management approaches across Australia. They can be used as a guide and are found at http://www.animalwelfarestandards.net.au/files/2016/08/Standards-Guidelines-Goats_FA.pdf

NSW Legislation

In NSW, the general law relating to animal welfare is *The Prevention of Cruelty to Animals Act 1979* (POCTA).

This Act states that:

‘A person in charge of an animal shall not fail to provide the animal with food, drink or shelter, or any of them, which, in each case, is proper and sufficient and which it is reasonably practicable in the circumstances for the person to provide.’

Your livestock and other farm animals are your responsibility and it is up to you to plan and prepare for their welfare. By being proactive and making decisions early, you will help ensure good animal welfare outcomes and compliance with POCTA. Penalties can apply for people who do not provide for the welfare of their animals.

Where there are ongoing animal welfare concerns POCTA allows an enforcement agency to request the formation of a Stock Welfare Panel. Stock Welfare Panels seek to improve the animal welfare outcomes for the stock through a structured process. Subsequent to advice from the Panel, NSW DPI may issue written instructions (an official warning notice) for the care of the animals to be completed within a set timeframe. The Panel will monitor, assess and report on compliance. If the owner or person in charge does not comply, NSW DPI may issue an order to seize and dispose of the stock by way of sale or otherwise.

Livestock standards and guidelines that are mandatory under POCTA are:

- » Prevention of Cruelty to Animals (Land Transport of Livestock) Standards 2013. (<https://www.legislation.nsw.gov.au/regulations/2013-559.pdf>)
- » Animal Welfare Code of Practice – Commercial Pig Production (www.dpi.nsw.gov.au/animal-welfare/pig-production)

Please also refer to *Welfare scoring nutritionally deprived beef cattle, dairy cattle and their crosses, sheep and horses* - https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0012/449796/welfare-scoring-nutritionally-deprived-cattle-sheep-horses.pdf

Biosecurity matters

Buying in hay and grain for drought feeding exposes your farm and the community to biosecurity risks. It is important to restrict the areas where stock are fed. Choose paddocks that are easy to quarantine and manage if unwanted pests, disease or weeds are introduced.

Always check where the hay and grain you purchase was grown.

Red imported fire ant (RIFA) is a major pest causing serious damage to crops and the environment and its intensely painful bite affects human health. A quarantine zone is in place in Queensland where eradication of RIFA is underway.

Hay from inside the quarantine zone must be accompanied by official certification ensuring the hay has been treated to prevent RIFA infestation. Check the following website for a detailed map of the RIFA quarantine zone https://www.daf.qld.gov.au/__data/assets/pdf_file/0004/58153/RIFA_IPQ_SEQ.pdf

When purchasing whole lupin grain confirm it was not grown in Western Australia or South Australia even if it is supplied from another state. Whole Lupins from WA and SA are not permitted entry into NSW as they carry the risk of lupin anthracnose. NSW is currently eradicating this disease, which was found in an isolated area in the south of the state. Lupin anthracnose could decimate lupin crops across NSW if it becomes endemic.

The possible movement of weed seed should also be considered when introducing hay and grain.

Be aware of the risk presented by vehicles and machinery moving on to your property. ‘Come clean, go clean’ protects you, the community and the economy.

Beef cattle description and management system

A national guide to describing and managing beef cattle in low body condition is available on page 32.

The NSW DPI web page has information on animal welfare including links to relevant legislation www.dpi.nsw.gov.au/animal-welfare

A useful guide to assessing animal condition is the DPI publication Welfare scoring nutritionally deprived beef cattle, dairy cattle and their crosses, sheep and horses. (www.dpi.nsw.gov.au/animal-welfare/scoring)

Further information on animal welfare can be obtained from the RSPCA. Visit www.rspcansw.org.au

Preventing animal health problems during drought

The health, nutrition and management of livestock are inextricably related. As drought sets in, under-nutrition will threaten animal health unless a management plan is in place to prevent problems occurring. In Australia, drought is part of the expected management cycle, and all producers should plan in advance what they will do when feed or water runs short.

Take the hard decisions early, and reduce numbers of stock to a point where you can afford to feed them properly, so that the remaining animals will remain healthy and fertile. It is a big mistake to keep too many stock and 'half feed' them. This leads to welfare problems, and to losses through reduced fertility, malnutrition (vitamin and mineral deficiencies etc.), metabolic disturbances (especially in pregnant stock), and eventually starvation.

When feed supplies run short, consider these factors in order of importance:

- » deficiency of energy
- » deficiency of rumen-digestible protein (or alternative nitrogen and sulfur equivalent) required by rumen bacteria to produce energy and protein from low-quality feed; deficiency of high-quality protein required for growth, pregnancy and lactation
- » deficiency of other minerals, particularly phosphorus, calcium and magnesium
- » deficiency of vitamins associated with the lack of fresh green feed, particularly vitamins A, D and E.

Young animals and pregnant or lactating animals have much higher energy and protein requirements than dry stock, and are most susceptible to the effects of malnutrition. Aged animals are also at risk. These animals will need to be fed separately to ensure that their requirements are met.

Preventative herd health programs

Food and water of adequate quality and quantity are the most important ingredients in keeping an animal healthy.

However, other factors will affect an animal's susceptibility to disease during drought including:

- » condition of different classes of stock when drought sets in
- » stage of pregnancy or lactation
- » any disease already present
- » current immunity levels to common diseases either through vaccination or previous exposure
- » current parasite burdens, both internal (e.g. worms, fluke) and external (e.g. lice, buffalo flies, blowflies)
- » crowding at feeding and watering points, which may result in infectious agents, such as viruses and bacteria, concentrating in these vicinities, thereby facilitating spread
- » congregation of potential disease carriers of other species at diminishing water sources, which may increase the risk of exposure to various diseases
- » unaccustomed close interaction and confinement with other cattle (especially strangers) and/or humans, which may impose high levels of stress on cattle, reducing the ability of the immune system to protect from disease
- » the introduction of new feeds such as grain and pelleted feed, which may lead to digestive upsets if not managed with sufficient care. Digestive upsets can predispose stock to diseases such as pulpy kidney

- » lack of green feed, which may induce cattle to eat plants that they would not normally touch including those that are poisonous.

Herd health programs that are recommended in good times are essential during drought including:

- » 5-in-1 vaccination to prevent clostridial diseases, which are far more likely to occur when there are sudden changes in feed type, quality or quantity
- » leptospirosis vaccination (or 7-in-1 instead of 5-in-1)
- » lice treatment in cooler months
- » drench for internal parasites (including fluke in fluke areas), especially young stock (if retained) and bulls.

Extra practices recommended during drought include:

- » Giving vitamin A, D and E (either in feed or as an injection) after 2–3 months on dry feed
- » If grain feeding, adding 1% limestone by weight of grain to correct any possible calcium-to-phosphorus imbalance
- » Discussing with your veterinarian the need for a coccidiosis prevention program in early-weaned calves.

Water management

The decision to hand feed cattle must consider the quantity and quality of water available. Is the water supply good enough to assemble large numbers of cattle in one place? Will it be easier to feed near the best water supply, or improve the water supply at the most convenient feeding location? If you will soon run out of water, it may be better to sell all stock.

Beware of deteriorating water quality. If stock reduce their intake of water because it is unpalatable, they will also tend to eat less, even while pasture is still adequate. Reduced water intake will also predispose stock to bladder stones.

Poor water quality is more likely to be a problem if cattle have direct access to dams. As the volume of water decreases, the dam turns into a quagmire and weak animals may become bogged. If possible, fence off dams, and water cattle from troughs.

If troughs are used, ensure that the water is not being contaminated with dung and/or grain. Grain washed from cattle's mouths will rapidly ferment, which may contribute to digestive upsets. It can also act as a food source for bacteria (including bacteria that are potentially pathogenic to humans as well as cattle), which the cattle will then drink.

Troughs should be cleaned on a regular basis when cattle are eating grain, but this may not be possible if water is in short supply. It is a good idea to set up feed troughs further away from the water supply so that cattle will have swallowed most of the grain in their mouths before they reach the water.

Feed management

Once pasture is inadequate, cattle should be confined and fed. Confined cattle need significantly less energy for maintenance than those that are left in the paddock to wander in search of feed. The pasture should be left in a condition where it can recover quickly when the drought breaks, and not be 'flogged' completely bare.

NOTE: Any change in feed (especially grain) should be introduced gradually – failure to do this is probably the major cause of illness in livestock during drought.

Recognising sick cattle

When cattle are being hand fed daily, you should take the time to observe normal behaviour so that it will be easier to recognise when there is a problem.

It is a good idea to take note of the following:

- » Normal parameters:
 - respiratory rate in resting cattle in cold and hot weather
 - how much faster they breathe when they are put up the race
 - how obvious or slight the normal respiratory movements are
 - how much mucus the average animal has in its nostrils
 - normal behaviour, head position, whether ears droop etc.

Abnormal signs include:

- » animals that stand apart, especially if depressed, ears drooped
- » animals that do not eat
- » fullness in flanks – bloat
- » reluctance to move or get up when others do
- » look for swelling of the legs, lame animals, or those standing oddly, for example leaning back, or shifting weight from one foot to another
- » animals that seem restless or irritable, swishing the tail or kicking at the belly
- » excess salivation, shivering, panting.

The normal temperature for adult cattle is 38°C. If you suspect that an animal is ill, take its temperature and call a veterinarian if the temperature is abnormally high or low.

Look at the consistency of the dung, particularly while introducing grain to the ration. Pale pasty dung or diarrhoea may indicate feed problems or gut infections.

It is also important to detect any animals that are being bullied or not eating the ration. You may need to remove these cattle and feed them separately.

Feed-related illnesses occurring during drought*Malnutrition and starvation*

Malnutrition due to lack of energy and/or protein will be the most common disease during drought, unless you take active steps to prevent it. Animals under your control are your responsibility. It is an offence under the *Prevention of Cruelty to Animals Act 1979* to fail to provide adequate feed and water. If you cannot afford to feed or agist animals, they should be sold or humanely destroyed. Stock should not be allowed to fall below condition score 2).

In the absence of a disease such as liver fluke, if young stock start to develop pot bellies or bottle jaws, this is a sign of protein deficiency and more protein and energy will need to be provided.

Metabolic Disease

Metabolic disease occurs when energy intake does not keep pace with energy demand. Even fat cows can die if they lose weight too rapidly. When the increasing energy demands of pregnancy are far greater than energy intake, pregnancy toxaemia develops. This is more likely to occur in fat females than thin ones, especially (but not only) in those carrying twins. Because twins are far more common in sheep, most sheep producers will be aware of this condition, but it can also occur in cows when feed is inadequate.

Pregnancy toxaemia is one form of ketosis, in which the breakdown products of fat, called ketone bodies, build up in the brain and become toxic. Toxaemic animals may have an altered temperament. They do not respond normally to handling or driving. They may seem more stubborn or stupid, and can sometimes be caught in the paddock. If not treated quickly, these animals will start to refuse feed.

Cows with pregnancy toxaemia or ketosis can be drenched with glucose or commercial preparations containing propylene glycol such as Ketol® or Ceton®. Even with veterinary intervention, this process is difficult to reverse, and often the animal dies or must be euthanised. To avoid these problems, separate pregnant and lactating animals so that they can be fed more. All animals should have access to adequate roughage, especially in cold weather and if lactating. (Roughage generates more heat internally, and improves milk production.)

Mineral deficiencies and imbalances

Mineral deficiencies may occur if balanced ration is not fed.

Hypocalcaemia. The most common mistake is to feed cottonseed or grain, which are high in phosphorus, without adding calcium (garden lime). The calcium to phosphorus ratio should be about 2:1. Lime at a rate of 1–2% must be added to all grain supplements, including cottonseed. If the ration is not balanced, pregnant cows may go down, primarily due to low calcium in their blood. An animal that seemed fine one day may be found sitting on her brisket, refusing to rise.

If these animals are suffering only from a calcium phosphorus imbalance, they will often get up immediately if calcium is given into the vein. Subcutaneous injections are not often sufficient. If they are also in negative energy balance – that is, losing weight, then treatment is less likely to be successful, as the cow is likely to have other metabolic problems.

Calcium is also involved in muscle contraction, so low blood calcium may also contribute to the increased incidence of vaginal prolapses.

Hypomagnesaemia (low blood magnesium) is more common in cold conditions, when lush growth occurs in spring. It can also occur in the 'green drought' stage of a drought, after showers have resulted in the growth of short green pick, if this is the main source of feed. New growth is very high in potassium, which competes with other minerals like calcium and magnesium for absorption in the gut and hypomagnesaemia can result. In this condition cattle develop twitches or muscle tremors. They may become more excitable and aggressive, and usually die quite quickly from convulsions.

Cattle on short green pick should be supplemented with hay. Causmag at about 60 g/cow/day can be mixed into a slurry and poured over the hay to help prevent further problems.

If possible, cattle should be confined and hand fed until pasture is adequate to sustain them. They frequently burn more energy than they harvest if allowed to wander in search of short green pick.

Reduced fertility

To maintain cow fertility, wean calves that are over eight weeks old and feed them separately – supplementary feeding of cows so that they can produce adequate milk for feeding calves is not an efficient use of feed. If cows are dried off, it is easier to keep them in good enough condition for becoming pregnant next season. It makes no sense to feed a cow if she then fails to conceive at the next joining.

If feed supplies are limited, allow mature cows to lose some weight prior to joining, but feed them over the joining period so that they gain weight. Heifers must reach a critical mating weight of around 280kg prior to joining, and continue to gain weight over the joining period.

A bull's fertility and its ability to work will be affected if it is allowed to slip into poor condition. Semen quality is determined around two months before use, so it is essential that bulls are in good condition well before the start of mating.

Acidosis

Eating too much grain too quickly can result in an excessive build-up of lactic acid in the rumen. Any factor that causes variation in intake (e.g. inclement weather, or palatability of feed) or changes the availability of the carbohydrate (e.g. a change in grain type, or how finely the grain is ground) may cause digestive upsets at any time, not just in the period of grain introduction.

Hammer or roller mill changes are an important factor here. Pellets are usually 90% grain and can also be responsible. The ration must be consistent from day to day, particularly if there is no access to other feed. Any change of feed should be introduced slowly. 'Shandy' the old batch of grain with the new, even when the two batches of grain are the same type. Additives such as sodium bentonite and virginiamycin (Eskalin®) can also be used to reduce the risk. Manufacturers sometimes change the type of grain used in pellets, so some of the old batch should be mixed with the new batch, gradually increasing the proportion of the new feed, to reduce the chance of upsets.

Acidosis can worsen if an animal is also suffering from cold stress. Affected animals show obvious signs of discomfort and are usually disinclined to move. They may kick at their belly or grind their teeth. Bloating is sometimes apparent, and scouring (light-coloured, smelly faeces) is usual. Acute cases show staggering, and appear blind and 'drunk'. Death can occur 12–72 hours after the onset of signs.

If treated early, mild cases often respond to a drench of sodium bicarbonate: 120g followed by 60g every 8–10 hours for the next day. One hour after the first treatment, give 0.5 L liquid paraffin or other vegetable oil.

Bloat

Bloat occurs when gas accumulates in the rumen and is unable to escape. Legume roughages and very fine particles of shattered grain predispose cattle to gas formation.

Drench the affected animals with at least half a cup of oil (peanut, paraffin or linseed) or use proprietary formulations of bloat oil as per the instructions provided. Call a veterinarian for severe cases – the animal may need to have a stomach tube passed or 'tapping' of the left flank with a trocar and cannula.

Chronic, persistent cases may require an anti-bloat agent to be mixed in with the feed. Access to fibrous, stalky lower-quality roughage will help to reduce bloat. Reduce the amount of legume roughage if bloat is a problem. Wetting the grain before processing can also help.

Clostridial diseases

Spores of clostridial bacteria (such as those that cause pulpy kidney, blackleg and tetanus) are present in soil, and are ingested or can contaminate wounds when dust is stirred up, or when animals ingest soil when grazing close to the ground. Disease is most common in young animals in good condition.

Pulpy kidney usually occurs following an intestinal upset either at the sudden introduction of feed changes, usually grain, or when the drought breaks and animals are turned onto lush green pick. All stock should be fully vaccinated with 5-in-1 vaccine to prevent all clostridial diseases.

Founder

Founder is characterised by lameness, often in all four feet. Incorrect ration formulation, too much grain, or too low a protein level, can contribute. Digestive upsets result in the release of toxins that affect the circulation, especially in the feet, and there is heat and pain in the coronary band of the hoof. The animal may lean back to take the weight off the front feet, so that feet are forward of vertical. If the animal is forced to move, its gait will be shuffling and stumbling.

Mild cases often recover without treatment if the ration is corrected. More severe cases require urgent veterinary attention. The condition may become chronic in animals that adapt poorly to grain, and you may need to sell these animals or feed them a much higher proportion of roughage.

Urea poisoning

A maximum of 1% urea in the ration is recommended. It is possible for excess urea to be consumed when there is inadequate mixing of feed or roller drum mixes, allowing pockets to accumulate, or when rain forms pools of water with a high nitrogen content in troughs or around blocks. Blocks left out in the rain may also soften sufficiently so that they can be eaten in chunks rather than licked.

Severe abdominal pain, shivering, bloat and salivation may be seen 20 to 30 minutes after feeding the ration, or after rain if blocks have been left out in the weather. If poisoning is detected early, drench immediately with 4L of vinegar to reduce absorption of urea. Call a vet urgently, as surgery may be necessary to empty the rumen. Further treatment could be drenching with 0.5 L water: 0.5L vinegar : 1kg sugar/molasses if poisoning is not severe.

Treatment is often not successful because the animal is too far gone when found. These animals should be humanely destroyed.

Urinary calculi (bladder stones)

Bladder stones are usually only a problem in steers, when stones block the urethra and prevent urination. Factors that predispose stock to stone formation include the high phosphorus levels in grain, too much sodium bicarbonate in the diet (used to help prevent acidosis), and reduced water intake due to poor water quality. Vitamin A deficiency is also a cause of bladder stones in cattle that have been on dry feed for prolonged periods.

Signs of bladder stones are usually only apparent when the urethra is blocked. Watch cattle for straining, dribbling of blood-stained urine, kicking at the belly or twitching of the penis. If the bladder ruptures, there is temporary relief, then depression, loss of appetite, peritonitis and death. Another possibility is that the urethra may rupture at the bend near the scrotum (sigmoid flexure), in which case the underline will fill up with fluid ('water belly').

Usually, emergency slaughter is the only option. If the bladder has ruptured, the animal will be condemned.

The addition of about 1% limestone to the diet will balance the excessive phosphorus levels present in high-grain diets.

Vitamin A deficiency

Vitamin A deficiency usually occurs after animals have been without green feed for more than six months. In a drought situation, deficiency is unlikely in animals still in the paddock with access to green pick from occasional showers, or if trees such as Kurrajong are being lopped to feed them. Sheep are less likely to develop a deficiency because they can graze green pick much closer to the ground.

However, vitamin A deficiency may occur in young cattle being lot fed, especially if they were born into drought and have seen very little green feed in their lifetime. Deficiency may affect growth rates of young stock prior to other signs becoming apparent.

Vitamin A deficiency may also cause lameness, swelling of the hind legs (especially hocks), increased respiratory rate, panting, drooling, and elevated rectal temperatures. Vision may be impaired, especially in low light ('night blindness'). To check this, walk through your cattle at dusk and try to sneak up on some.

Vitamin A deficiency more commonly occurs in hot weather, and affected animals are more susceptible to heat stress. Vitamin A deficient cows can have abnormal calves, so it is a wise precaution to supplement cows if the decision has been made to re-breed, in spite of the drought. To prevent vitamin A deficiency, give vitamin ADE injections or add green chop to the feed if stock have had two to three months with no access to green feed.

Plant poisoning

Hungry animals will look for any green pick and may consume plants including shrubs and trees that they would normally avoid. Poisonings are common when stock are sent on agistment and consume plants they are not familiar with. Short regrowth of many plants normally eaten (e.g. sorghum and oats) may contain levels of nitrate or cyanide that are toxic to hungry animals.

Symptoms will depend on the toxin involved. Nitrate and cyanide (prussic acid) poisoning cause acute respiratory distress and sudden death. Other poisons may cause nervous signs, staggering gait, or diarrhoea. Mouldy feed can cause digestive upsets and precipitate abortions.

Call your vet to all suspected poisonings. If you suspect nitrate or cyanide poisoning, do not attempt to move animals that are in severe respiratory distress.

Check any proposed agistment paddock for any unusual plants, especially if the plants are still green. It is a good idea to fill animals up on hay before releasing them into a paddock of regrowth.

Blue-green algae

Blooms of blue-green algae are more likely to appear in warmer months during drought, when water levels in dams or ground tanks are low and watercourses stop flowing. Pollution from manure or fertiliser run-off will make the problem worse. Ingesting large amounts of algal toxins can cause liver damage and death in stock. Lower doses of toxin may result in jaundice and photosensitisation. Photosensitisation results in sunburn, particularly of the face, ears and white-haired parts of the body, so it is important to provide adequate shade for affected animals. A vet can provide treatment that can help the liver to recover.

Toxicity of blooms is highly variable, but tends to be worse during a rapid build-up phase, or as the algae are disintegrating. Problems may occur when algae concentrate on the shore of a dam, before the wind, if this is where stock drink. However, cattle will normally not drink affected water unless they have no alternative. If stock show any reluctance to drink, it may be because of the presence of blue-green algae, and you should provide an alternative supply if possible. Water can be sent away for testing, but because toxicity can vary considerably from day to day, the situation may change by the time you receive the results.

If a bloom is suspected, you should find an alternative supply of water for domestic, stock and irrigation use until the algae is identified. If there is no alternative for stock and irrigation use, then use water from deeper in the river or dam, or from areas not covered by scums as these may be less contaminated. It may also be possible to allow stock to drink from an area on the upwind side of the bloom if the bloom is localised.

In farm dams, aeration can help mix up the water and add oxygen. This can help control accumulations of soluble iron, ammonia and hydrogen sulfide as well as help control algal blooms. Aeration can be achieved by cascading the water into a holding dam or tank or using an aerating pump.

In NSW, only Coptrol Aquatic Algicide®, Cupricide Algicide® and Cupricide 110 Algicide® are approved for the control of blue-green algae and some other algae types. They must be used in strict accordance with their label conditions and directions. These products are registered for use in farm dams, rice paddies and irrigation conveyance systems. They must not be used in rivers, streams, creeks, wetlands, lakes or billabongs, and water treated with these products must not be allowed to spill into these water bodies.

Conditions of use further prevent their application when birds are feeding on algae or in water containing fish. As with all chemicals, read the instructions before use and wear the appropriate safety equipment. Do not treat drinking waters used by farm animals grazing on heliotrope or ragwort.

Diseases unrelated to feed

If animals are confined in yards or small paddocks, any disease-causing organisms or parasites that are often present in low numbers without causing problems will become more concentrated. The risk of spread of disease or parasitism is increased.

The use of troughs will minimise this contamination. If troughs are not used, feeding points should be changed at frequent intervals, where possible.

Diarrhoea

Correcting the ration formulation will cure many cases of mild diarrhoea, but if the problem is more severe, bacterial infections including infections by coccidia, salmonella, *E. coli* and several others are likely causes.

These diseases are more common in calves, but can also occur in older animals, especially if they are stressed and in poor condition.

The symptoms of these diseases are:

- » Salmonellosis causes a high fever and depression. It may also cause 'joint ill', and therefore lameness, in young calves. There is usually, but not always, bloody diarrhoea.
- » Coccidiosis can also cause bloody diarrhoea, and animals can become weak and uncoordinated.
- » With *E. coli* scours, the diarrhoea is pale, profuse and watery, and death is usually due to dehydration.

If you suspect any of these diseases, call your vet promptly. With salmonellosis and *E. coli* infection, fluid replacement is the most crucial treatment, although antibiotics are often given at the same time. Coccidiosis is usually treated with sulfonamides,

The ionophore group of growth promotants (eg Bovatec®) help control coccidiosis. In feedlots, since their use has become widespread, coccidiosis has become much less common.

Bovine respiratory disease

A range of bacteria and viruses can contribute to respiratory disease. Problems are more likely to arise if animals from cumulative stress factors such as saleyards, transport, mixing with unfamiliar animals and poor animal handling. Dry dusty conditions are also predisposing factors.

Symptoms of respiratory disease may vary from a mild, barely detectable illness, to animals found dead. Depending on the severity of the illness, animals may be off their feed, or have nasal discharge, fever, depression, coughing and laboured breathing.

Call your vet promptly if any signs of respiratory disease appear. Viruses will not respond to antibiotics, but viral infections are frequently followed by secondary bacterial infections, so it is usual to treat with broad-spectrum antibiotics such as tetracyclines. Vaccinations are available to help prevent infection.

Pinkeye (infectious keratoconjunctivitis)

The bacterium responsible for pinkeye, *Moraxella bovis*, is spread by dust and flies so it can be a major problem when animals are confined. Any eye damage, for example from grazing among thistles, will predispose an animal to infection.

The first sign is tears running down the face, followed by the classic inflamed pink eye. In severe cases an abscess forms in the centre of the cornea, which may burst leading to the loss of the eyeball.

Antibiotics are the preferred treatment. Patches glued over the eye will speed recovery and will also prevent flies spreading the disease more widely.

However, if animals are not severely affected, it may be better not to treat them. Stressing the group further by putting animals through a race to treat them, and stirring up dust that might possibly spread the condition, may worsen the situation.

A preventative vaccine is available, which must be given before high-risk periods.

Parasites in drought

Worms and fluke

Worm infestations are more likely to cause problems in young cattle and recently calved cows. Adult cattle are normally fairly resistant to the effects of worm infestation, but stress can increase susceptibility in animals that are in poor condition. Usually, mixed infestations occur, but the most important is that of the small brown stomach worm (*Ostertagia ostertagi*). Bulls can be susceptible to ostertagia infection.

Fluke can be more of a problem in dry times. Stock that congregate in damp areas that supply the last of the green pick are exposed to the snail that is the intermediate host for fluke.

Crowding around feeding sites will increase contamination, but while the weather remains dry and vegetation is lacking, egg survival is likely to be poor. Parasitism is less likely if animals are confined to yards with troughs. Worms may be more of a problem when the drought breaks, or when cattle are sent away on agistment to areas that have had good rain.

Signs of worms and/or fluke include scouring, loss of appetite, anaemia and ill-thrift, with submandibular oedema ('bottle jaw') in more severe cases.

The parasites concerned should be identified if possible. In fluke areas, faecal tests will differentiate between fluke and worm infestations. A fluke drench must be used in the case of fluke. If worms are the cause, it is important to use a drench that is effective against the dormant larval stages of ostertagia.

Lice

Cattle seem to be more susceptible to a build-up of lice if they are in poor condition, especially in cold weather. Cattle infected with lice will often scratch on sharp objects, and this can cause wounds that will make animals more susceptible to infection by clostridial bacteria. Cattle can damage equipment, especially feed and water troughs, making repairs necessary when you have more important things to do.

Consider treating hand-fed cattle for lice before a problem is apparent, especially if winter is approaching. All animals should be treated at the one time, according to the manufacturer's instructions. If the preparation used does not have a sustained action, and does not kill eggs, re-treatment is necessary after about 14 days. This time interval is crucial, as it allows eggs to hatch and be killed at the immature nymph stage, before they can lay eggs themselves and continue the cycle.

More information is available at

www.droughthub.nsw.gov.au

www.dpi.nsw.gov.au/animals-and-livestock

Cattle movements and Johne's disease (BJD)

Johne's disease in cattle is a chronic bacterial disease causing wasting and ultimately death in affected cattle. The disease is usually spread by movement of the affected cattle. Increased stock movements from property to property during droughts can increase the risk. Previous legislative controls on cattle movements were abolished in July 2016. It was replaced with a new industry framework that recognises the key role producers have in the management of diseases on their property. The key principles have a reliance on producers to protect their livestock from disease by on-farm biosecurity management practices and a market driven approach where producers choose management practices that meet their marketing and business requirements.

More information is available at:

www.dpi.nsw.gov.au/bjd

Sheep health

There are a number of conditions that occur more commonly when drought-feeding, especially when sheep are congregated on small areas for feeding. Some of these conditions and prevention and control recommendations are discussed below. Many diseases in sheep are orally transmitted including salmonellosis, worms, coccidiosis, and Johne's disease. The spread of these diseases can be minimised by avoiding faecal contamination of feed and by regularly changing the areas in a paddock where sheep are fed.

Affecting all ages

Acidosis

Cause: Grains are highly fermentable carbohydrate-rich foods. Following ingestion of excessive quantities there is a sudden change in the microbe population in the rumen, which leads to the formation of large amounts of lactic acid that causes this condition. See *Primefact 330 Grain poisoning of cattle and sheep*.

The condition commonly occurs when:

- » sheep are first given access to grain
- » there is a sudden increase in the amount of grain being fed

- » too much grain is fed allowing excessive consumption
- » there is a change in the type of grain or concentrate being fed or even the same grain type but from differing sources.

Clinical signs: Vary from mild to acute, depending on amount of grain and previous experience with grain. In milder cases, sheep are depressed, anorexic (do not feed) and ataxic (unstable on feet). In severe cases there is scouring, abdominal pain, acute lameness with heat and pain around coronet (laminitis), apparent blindness, recumbency and death.

Treatment: Based on neutralising the excessive ruminal lactic acid. Treat with 60 g Causmag (magnesium oxide) or 15 g sodium bicarbonate in 1 litre of water as a drench for each sheep. Affected sheep should be given roughage such as hay until recovered. Drafting off the affected sheep may be practical in large mobs with small numbers affected. Valuable stock should receive veterinary attention.

Control and prevention: Follow guides for introducing sheep to grain. The first day of a feeding program commences when sheep start to eat the grain when fed. Do not allow a build-up of grain in the paddock.

When changing feeds, there should be a gradual changeover. If changing from wheat to oats or oats to barley, mix the new feed into the old feed over at least four feeds before the old feed cuts out. Add 2 per cent sodium bentonite to grain rations. This will help reduce the risk of poisoning during grain introduction.

Enterotoxaemia (pulpy kidney)

Cause: Enterotoxaemia is an acute toxæmia caused by the proliferation of specific clostridial bacteria that produces toxins in the intestines. These bacteria, normally present in the gut, multiply and produce toxin whenever the movement of food through the gut is slowed e.g. by grain poisoning.

Clinical signs: Usually sudden death, with rapid decomposition of the carcass, purple discolouration of skin, wool is easily plucked.

Control and prevention: All stock should be given a clostridial booster vaccination before feeding. If sheep have not been vaccinated, a full vaccination program should be implemented immediately.

Worm infestations

Sheep in drought-feeding situations can be more susceptible to internal parasites. Sheep that are stressed for any reason can also lose their immunity and may show the effects of worm infestation – e.g. stress through lactation.

Cause: The worms commonly involved are brown stomach worm and black scour worm. Where sheep congregate in wet damp areas or after rain, barber's pole worm, and *Nematodirus* (thin-necked intestinal worm) may also cause problems.

Clinical signs: One or more of these signs may be present: ill-thrift, anaemia, exercise intolerance, and scouring. If sheep are scouring, it may not be worms so it is important to determine the cause of the scouring before reaching for a drench gun. Check using a WormTest.

Treatment: When worms are confirmed, drench the sheep with an effective drench.

Control and prevention: Ensure that the sheep are on an effective worm control program (for example Wormboss). If sheep are not on a program, do a WormTest first, then drench them if necessary with an effective drench before they are put into a feedlot, or before they are put into small yards or paddocks.

Liver fluke

Cause: This is more common in dry times when sheep graze the wet fluke-prone areas.

Clinical signs: Chronic fluke results in anaemia and ill-thrift. Severely affected sheep can develop bottle jaw. It can be confused with barber's pole worm. Acute fluke infestations often cause sudden death in sheep. Sheep with liver fluke are more prone to black disease in areas where it occurs but this can be prevented by a clostridial vaccination program using a multi-valent vaccine.

Treatment: Sheep affected with fluke should be treated with a triclabendazole drench (e.g. Fasinox®, Flukare®), which will remove both mature and immature fluke.

Control and prevention: Prevent sheep from gaining access to fluke-prone areas in drought times, particularly when they are being hand fed. For a list of drenches for sheep worms including liver fluke, see *Primefact 152 Anthelmintics (drenches) for sheep, goats and alpacas*.

Sheep lice

Cause: This is more common in a drought feeding situation for several reasons:

- » the congregation of sheep assists transmission between sheep
- » there is more movement of sheep between mobs and between paddocks
- » sheep in drought-feeding situations tend to have more tender wool and the clinical effects are more marked when sheep rub or bite.

Treatment: This depends on the length of wool on the sheep and the previous history. Seek advice on the most effective treatment. (See *Primefact 483 Sheep lice*.)

Plant poisoning

Cause: Hungry sheep gaining access to feed containing toxins – for example, when sheep are changed from a bare paddock to a paddock with some regrowth. Often plants not normally considered toxic may be eaten in excessive amounts and can cause mortalities. In drought situations, hungry sheep will eat plants that are not normally eaten.

Clinical signs: This depends on the toxins involved. Nitrate and cyanide poisoning will cause sudden death. Other plants may cause scouring and nervous signs including staggers and ataxia.

Treatment: This depends on the plant species involved. Seek veterinary advice if plant poisoning is suspected.

Control and prevention: Prevent hungry stock having access to toxic plants. Ensure sheep have a full stomach before they are moved out of a bare paddock.

Urea poisoning

Cause: Ingestion of excess amounts of urea in blocks, in mixed feed, or when sheep drink pools of water on the top of urea blocks after rain.

Clinical signs: Abdominal pain, nervous signs including excess salivation and sudden death.

Treatment: Not usually successful.

Control and prevention: Ensure that urea is mixed thoroughly with feed when used as a supplement. Keep blocks out of the rain in sheltered areas.

Salmonellosis

Cause: Faecal contamination of feed and water supplies with *Salmonella* organisms. It is often associated with stress and with sheep in areas that are wet and muddy following heavy rain or from overflowing water troughs. Coccidiosis, which may result in scouring and dysentery, can also occur under these conditions.

Clinical signs: Fever, scouring and sudden death.

Treatment: This requires antibiotic treatment and advice should be sought from your veterinarian.

Control and prevention: Prevent faecal contamination of feed and water. Do not keep sheep that are under stress in wet, muddy areas. Withhold affected sheep from slaughter until outbreak is controlled.

Pink eye

Cause: A bacterial infection of the eye that is aggravated by the congregation of sheep in dusty areas, especially if flies are present.

Treatment: Antibiotic ointment in severe cases. Most sheep will recover if left alone but ensure that they have access to feed and water.

Control and prevention: Difficult in drought situations when sheep are being brought into confined areas.

Urinary calculi (bladder stones) in wethers and rams

Cause: The common predisposing cause is a limited water intake. This can occur as a result of faecal contamination of water, stagnant or brackish water, or high salt content in the water. Losses also occur when sheep are fed on grain rations without a calcium supplement.

Clinical signs: Often sudden death. When sheep are examined there is a grossly enlarged bladder caused by an obstruction.

Treatment: Not practical and rarely successful.

Control and prevention: Ensuring that sheep have access to drinkable water supplies at all time best prevents the disease. An increase in the salt content of the ration may help to increase the water intake of sheep. However, this will only work if the water is drinkable.

Grass seed infestation of the gums

Cause: Feeding hay that contains a lot of mature grass seed.

Clinical signs: Sheep failing to eat, sometimes slobbering at the mouth. Examination of the mouth indicates masses of grass seed around the inside of the gums.

Treatment: Removal of the grass seed.

Control and prevention: Take care when feeding pasture hay heavily contaminated with grass seed.

*Affecting mainly young sheep**Enterotoxaemia*

This is more common in young stock and the same precautions described under 'Affecting all ages' (above) should be followed.

Pneumonia

Cause: Bacterial infections aggravated by dry, dusty conditions. It is more common where lambs are being fed on dry, dusty feeds in troughs, especially finely hammer milled hay.

Clinical signs: Nasal discharge, coughing, ill-thrift and sudden death.

Treatment: In severe cases, antibiotic treatment can be used as advised by a veterinarian.

Control and prevention: Avoid feeding dry, dusty feeds. This may require some damping down of the feed in troughs.

Vitamin A deficiency

Cause: Vitamin A deficiency can occur in lambs born to grain-fed or drought-fed ewes. Grain and most hays are low in Vitamin A. Lambs must be completely off green feed for some months before clinical signs will occur.

Clinical signs: Night blindness, eye discharges and ill-thrift.

Treatment: Vitamin A drench.

Control and prevention: Lambs off green feed or lucerne hay for three to four months may need a vitamin A supplement. A single drench should give six months protection.

Vitamin E deficiency

Cause: Vitamin E deficiency is often associated with feeding weaners on hay or grain over extended periods, especially young weaners.

Clinical signs: Animals go down. They appear bright and alert but they are reluctant to stand. In other cases there is sudden death. Examination of dead animals reveals pale muscles.

Treatment: When the diagnosis is confirmed, treat with an oral drench of water-soluble Vitamin E using a dose rate of 3000 IU per animal.

Control and prevention: Oral vitamin E drenches every 6-8 after pasture senescence, until sheep graze green pastures again. Watch weaners and young sheep for signs suggesting Vitamin E deficiency and seek advice. Vitamin E deficiency can resemble white muscle disease due to selenium deficiency. However, selenium deficiency is very unlikely in a drought situation.

Nematodirus infection (thin-necked intestinal worm)

Cause: A mass hatch of *Nematodirus* worm eggs after an autumn break when sheep graze on short green pick.

Clinical signs: Scouring, ill-thrift and weaner deaths. Clinical signs may occur before there is an increase in *Nematodirus* egg counts on WormTest.

Treatment: Drench with an effective drench.

Control and prevention: Difficult because of the long-term survival of the *Nematodirus* eggs and the mass hatch following the autumn break or rain after a prolonged dry spell.

Coccidiosis

Cause: Stress and overstocking of lambs and weaners under moist conditions – such as muddy feeding and watering areas. Heavy pasture contamination and stress can lead to a build-up of infestations. The clinical effects are aggravated by concurrent worm infestations.

Clinical signs: Scouring with watery faeces that may contain blood, lack of appetite, dehydration, with anaemia and ill-thrift in some cases.

Treatment: Confirm diagnosis and seek a veterinarian's advice.

Control and prevention: Avoid placing lambs and weaners in situations where gross faecal contamination of feed will occur.

Teeth abnormalities

Cause: Long-term feeding of weaners on grain without calcium supplementation.

Clinical signs: Dribbling from the mouth and abnormalities of the molar teeth.

Control and prevention: Ensure that young sheep on grain rations receive a calcium supplement of at least 1.5 per cent of their ration in ground limestone.

Affecting adult sheep

Periodontal disease

Cause: Often faulty molar dentition. The incisor teeth are not so important. The effect of molar teeth abnormalities may not become obvious until sheep are stressed in drought feeding situations.

Clinical signs: Ill-thrift, emaciation and sometimes a cud discharge from the mouth.

Treatment: There is no treatment. Remove affected animals from the flock.

Control and prevention: Cull old sheep early in the drought rather than hand feeding them.

Johne's disease

Cause: A chronic bacterial infection of the intestines in sheep, which becomes more obvious when sheep are stressed.

Clinical signs: Wasting and ill-thrift in sheep two years of age and older, which will not respond to drenching or other treatments. Sheep die within three to four months of first showing signs of the disease. Diagnosis is on post-mortem.

Treatment: There is no treatment.

Control and prevention: If animals are at risk from the disease, vaccinate with Gudair®. This is a once in a lifetime vaccine that provides effective protection against infection. In areas where OJD is a threat, supplementary feeding should be offered in troughs and feeders to avoid ingestion of soil. The disease is notifiable and you should seek advice from your local district veterinarian.

Affecting pregnant ewes

Pregnancy toxaemia

Cause: Poor nutrition in late pregnancy, especially in twin-bearing ewes. Outbreaks of pregnancy toxaemia are often brought on by stress.

Clinical signs: Affected animals are dull and listless and may appear blind and wander into objects. Animals eventually become recumbent and very depressed.

Treatment: Products such as Ceton®, Ketol®, Vytrate® or Lactade®. When cases occur, increase feeding levels.

Control and prevention: Ensure an adequate ration, especially for twin-bearing ewes. It is important that pregnancy toxaemia be differentiated from hypocalcaemia and polioencephalomalacia.

Hypocalcaemia

Cause: A sudden fall in blood calcium levels in late pregnancy and early lactation.

Clinical signs: Often sheep are found down or may appear listless. They may show some nervous signs. It commonly occurs shortly after lambing.

Treatment: Intravenous or subcutaneous calcium borogluconate.

Control and prevention: Prevent sudden changes of diet or other forms of stress. Calcium supplementation of diets is only recommended when sheep are being hand fed on grain and concentrate diets over several months. Sheep can also develop hypocalcaemia when grazing short lush green feed immediately after a drought has broken. Grazing of high oxalate plants such as sorrel, oxalis or portulaca can also cause hypocalcaemia.

Chronic copper poisoning

Cause: Long-term excessive intake of copper in the diet, or as a result of a build-up of copper associated with liver damage caused by grazing on Paterson's curse or heliotrope. Clinical disease is brought on by some form of stress for example, nutritional or lactation stress.

Clinical signs: Animals show severe jaundice.

Treatment: Incorporation of molybdenum in the diet will help control outbreaks. However, molybdenum should not be added to the rations of normal sheep as it may predispose to copper deficiency.

Control and prevention: The disease can be prevented in susceptible groups of animals by incorporating molybdenum at certain times on the advice of your veterinarian.

Toxoplasma abortion

Cause: Feeding of pregnant ewes on hay or grain contaminated with cat faeces.

Clinical signs: Abortion, dry ewes or the birth of small, weak lambs.

Treatment: There is no economic treatment once the outbreak commences.

Control and prevention: Ensure that pregnant ewes are fed on hay or grain that has not been contaminated by cat faeces. Silo- stored grain should be reserved for pregnant animals.

Campylobacter abortion

Cause: Bacterial infection of sheep picked up by ingestion of the organism. Carrier animals excrete the organism in their faeces. Outbreaks occur when ewes in the last two months of pregnancy are hand fed on the ground under cool, moist conditions when the organism will survive on pasture.

Clinical signs: Abortion in the last two months of pregnancy.

Treatment: There is little value in treatment in most circumstances. Valuable animals might be treated with antibiotics on the advice of a veterinarian.

Control and prevention: Outbreaks occur as a result of faecal contamination of feed. When feeding pregnant ewes, care should be taken to reduce the degree of faecal contamination – especially when sheep are being hand fed under cool, moist conditions. This may be shortly after a drought breaks where hand feeding continues until pasture growth is established.

OJD and sheep movement

For more information visit www.dpi.nsw.gov.au/ojd

NLIS and sheep movement

For more information visit www.dpi.nsw.gov.au/nlis/sheep

Section 5 Appendices

- » Appendix 1. Most likely dry matter (DM), metabolisable energy and crude protein content of feeds
- » Appendix 2. Decision Support Systems
- » Appendix 3. StockPlan

Appendix 1

Table 30. Most likely dry matter (DM), metabolisable energy and crude protein content of feeds

Foodstuff	Dry matter (%)*	ME (MJ/kg DM, or M/D)		Crude protein %DM	
		Average*	Tested range	Average*	Tested range
Low protein dry roughages					
Oaten and wheaten hay	90	8.5	(8.5–9.5)	6	–
Pasture hay (mostly grass)	90	9.8	–	12	–
Oat, barley or wheat straw	90	5.5	(4.5–5.5)	3.0	–
Sorghum / corn stubble	90	6.5	(6.5–8.0)	3.4	–
Cottonseed hulls	90	5.15	(2.9–6.3)	7.7	(4.0–11.5)
Rice hulls	90	2.4	–	2.0–3.1	–
Soybean stubble	90	5.5	(4.0–6.5)	5.5	(4–6.5)
Peanut hulls	90	3.6	–	3.3	–
Oat hulls	90	5.3	(5.3–5.4)	3.8	–
Sorghum (failed crop)	90	9.0	(8.5–9.5)	7.4	–
Peanut hay	90	8.5	(8.0–9.0)	9.3	(7.6–10.7)
Soybean hay (mature)	90	6.0	(5.5–6.5)	8.1	–
Wheat / barley stubble	90	5.5	(4.8–8.2)	3	–
Rice stubble	90	4.5	(5.3–6.6)	3	–
Oat stubble	90	6	–	3	–
High-protein dry roughages					
Lucerne hay	90	9.5	(8–9.8)	18	15–20
Clover / vetch hay	85–90	9.8	(8.3–10.9)	14	–
Cowpea and field pea	90	10	–	15	–
Soybean hay (full pods)	90	9.5	(9–10)	13–14	–
Soybean hay (75% pods)	90	8.5	(8–9)	17	–
Low protein wet roughages					
Maize silage	25–30	8.5	(7.5–9.5)	6.9–9.0	–
Sorghum silage	25–30	8.0	(8.0–8.5)	6.9–7.5	–
Oat, wheat, barley or rye green fodder or silage (cut at flowering stage)	25–30	8.5	(8.3–8.7)	6.0–8.0	–
High-protein wet roughages					
Lucerne green fodder	25	8.3	–	16	–
Lucerne silage	25–30	8.4	–	15	–
Pasture fodder (mixed grass & clover)	25	10.3	–	17.5	–
Pasture silage (mixed grass & clover)	20	8.2	–	16	–
Young oats, wheat, barley, rye, or millet grazing	25	9.3	–	10	–
Grains					
Maize	90	13.5	(13–14)	9.5	(9.0–10)
Grain sorghum	90	13	–	9	(5–11)
Wheat	90	13	(12.5–13.5)	12	(11–13)
Barley	90	13	(12.5–13)	11	(10–12)
Canola Seed (44.6 % oil)	94	24.5	-	31.6	-
Oats	90	12.5	(11–13)	10.5	(10–11)
Pulse grains					
Faba beans	90	12.5	–	25.6	–
Field peas	90	13	–	25	–
Lupins	90	13	–	32	–

Table 30. Most likely dry matter (DM), metabolisable energy and crude protein content of feeds

Foodstuff	Dry matter (%)*	ME (MJ/kg DM, or M/D)		Crude protein %DM	
		Average*	Tested range	Average*	Tested range
Cereal grain by-products					
Wheat pollard	90	11	—	15	—
Wheat bran	90	12	—	15	—
Oat bran	90	9	—	8.0	—
Hominy	90	12.6	—	11	(10–12)
Rice bran	90	11	—	14	—
Protein-rich concentrates					
Soybean meal	90	12	—	45	—
Safflower meal	90	9	—	22	—
Peanut meal	90	11	—	42	—
Cottonseed meal	90	10.5	—	41	28–43
Linseed meal	90	11.5	—	30–35	—
Sunflower meal	90	10.5	—	40–45	—
Coconut meal (6% fat)	90	12.5	—	21	—
Milk powder (cow's whole)	90	17	—	26.5	—
Milk powder (cow's skimmed)	90	12.8	(12.6–13)	36	—
Urea (46% nitrogen)	90	—	—	Equivalent to about 280	—
Canola Meal Solvent extracted (3% Oil)	94	12.3	—	44.2	—
Canola Meal - Cold Press (10% Oil)	94	14.4	—	41.4	—
Miscellaneous					
Distillers Dried Grain	94	12.6	—	21**	—
Molasses	80	12	—	2	—
white cotton seed	90	13	—	20	12–22
Sheep and cattle nuts	90	11	(9–13)	15	—

* This figure should be used as a guide only because of the wide variation between samples – laboratory testing of feeds is recommended.

**Available protein is around 17.5%

NSW Department of Primary Industries laboratory testing services

NSW DPI operates a network of laboratories across the state that offer a wide range of testing services to support rural and other enterprises. All laboratories are fully accredited by NATA to international standards and use the latest methods and equipment.

Services include:

Chemical residues: Tests include organophosphates, organochlorides, pyrethroids, and most other pesticides in a range of materials including water, soil, animal products, fodder and other produce. This service is currently sub- contracted on request to the National Measurement Institute (NMI) NATA accreditation no. 198.

Animal feeds: A full range of testing on pastures, silages, grains and by-products.

Water testing: Tests are tailored for agricultural uses and include pH, conductivity (salinity), alkalinity, hardness, chloride and trace metals.

Veterinary testing: Tests are available for diagnostic, market assurance and stock health monitoring purposes, as well as health certification for export purposes. Where possible, submit your samples through your veterinary practitioner or district veterinarian.

WormTest kits are available through LLS offices.

More information:

www.dpi.nsw.gov.au/about-us/services/laboratory-services

Contact Laboratory Customer Service 1800 675 623

Appendix 2

Decision support systems

There are a number of courses and computer software programs to help farmers make strategic decisions during periods of drought.

- » **Australian Rainman®** uses historical long-term daily and monthly rainfall data and the Southern Oscillation Index and Sea Surface Temperature data to allow producers to calculate the chances of daily, monthly and seasonal rain.

Available from www.daf.qld.gov.au/business-priorities/plants/field-crops-and-pastures/broadacre-field-crops/cropping-efficiency/rainman

- » **Drought Feed Calculator** (DFC) phone app allows the user to develop a drought feed ration for sheep and cattle. It calculates the daily feed requirement of dry, pregnant, lactating and growing animals using a database containing 71 different feeds. The app calculates the total amount and cost of feed required for a mob over a selected period. It is designed for use in the paddock or at the silos, no mobile phone coverage needed. There are 71 different feeds to select from each with its own estimated energy, protein and dry matter values. Values can be over written when feed test results are available (recommended). The user can easily assess the value of different feeds by simply comparing the results for up to three feeds as well a mixed ration. The phone app is free and can be downloaded from the App Store or Google Play – just search 'Drought Feed Calculator'. NSW DPI provides feed testing through the Feed Quality Service and can be contacted on 1800 675 623 or feed.quality@dpi.nsw.gov.au.
- » **Grazfeed** can be used to determine feed requirements and the value of feed supplements. GrazFeed® is available from:
Horizon Technology Pty Ltd PO Box 598
Roseville NSW 2069
Phone: 02 94408088
Fax: 02 94408011
Email: horizonag@hzn.com.au
- » **ProGrazePlus** is a fodder budgeting workshop series designed to evaluate and help manage grazing plans using a decision support program called ProPlus.
- » **StockPlan** is a suite of computer decision support tools to help cattle and sheep producers explore drought management options. The decision-making tools help producers make management decisions that minimise the environmental and financial impacts of drought. More details on StockPlan are provided in Appendix 3.

Appendix 3

StockPlan

StockPlan® Exploring management options for drought and recovery is a training program for sheep and beef producers, advisors and agribusiness, which focuses on developing least-cost strategies for drought and drought recovery using its three key computer decision support systems. Its greatest benefit is in long-term drought planning using 'what if' questions.

- » What if I stick to wool production or run dry sheep only, or even change to cattle?
- » What if the season dries up – will I feed, agist or sell?
- » Can my ewes or cows lose weight, or how much do I feed and at what cost?
- » What effect is selling going to have on my future flock and cattle structure?
- » When will my cash flow return to normal after a drought?

You decide which option you wish to consider, enter the numbers and think about the results. The results allow you to make sound judgements and act accordingly.

With funding from Australian Wool Innovation (AWI) and NSW DPI, StockPlan has a:

- » new producer manual
 - StockPlan Basics (Modules 1–4)
 - StockPlan Extras Home Study Guide
- » producer/participant's resources CD
- » facilitator's guide CD
- » new version of the decision support software
- » a StockPlan web page on the AWI and NSW DPI websites.

StockPlan training program

1. StockPlan software and user manual is a suite of computer decision support tools that enable cattle and sheep producers to explore management options in the early stages of drought and during drought. Management options are explored through three StockPlan tools: Drought Pack, Im Pack and FSA Pack and helpful advice through a number of StockPlan links.

StockPlan Basics producer manual contains information and activities to help participants to complete a **Drought Risk Management Plan** that can be incorporated into the farm's business plan.

StockPlan Basics is completed by the participant during the workshop sessions with some at-home tasks. The StockPlan Basics producer manual contains four modules. The tools of the StockPlan Software (Drought Pack, FSA Pack, and Im Pack) are progressively introduced to the workshop participants during activities outlined in the manual.

StockPlan Extras Home Study Guide and the **Drought Plan Templates** (on the Participant's resources CD), contain extra steps to help the participant complete a more detailed **Whole-farm Drought Risk Management Plan**. This is an optional program completed by the participant at home and follows on from StockPlan Basics.

2. Participants resources CD contains links and documents to support the manual and home study guide.

3. Facilitator's guide CD provides a step-by-step framework to help facilitators understand the program and to provide resources for delivery during the workshops.

StockPlan workshops are available for producers and agribusinesses to help improve drought management skills, lower the risk of degrading pastures and financial losses, encourage pro-active decision-making and provides a platform to investigate the production and financial implications for a farm business.

The StockPlan tools

Three decision-making tools are integrated into one package to help the user make informed and timely management decisions before and during a drought. The user can use one or all of the decision tools depending on their circumstances.

Drought Pack

Drought Pack is an energy-based model (MJ ME/kg fed) that assesses the cost of feeding and determines the break-even price for specific animal classes.

Im Pack

This tool uses a static modelling approach that allows the user to assess the structure of the herd or flock over a 10-year period.

It allows the user to explore a wide range of options such as selling-off parts of the herd or flock and recovering stock numbers over the following years.

FSA Pack

The FSA Pack ('feed', 'sell' or 'agist' decisions) is designed to evaluate the cost of the various options for a specific group of livestock rather than for a whole-farm analysis. FSA allows the user to specify up to four different drought lengths and provides cash cost estimates and 'bottom line' financial estimates.

For more details and workshop registration contact your Local Land Services Livestock Officer.

Notes

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