Nutrition of goats during drought

A report for the Rural Industries Research and Development Corporation

by B. A. McGregor

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Foreword

The mohair, cashmere and goat meat industries are establishing small industries exporting products valued at approximately $40 million pa. While the infrastructure and supply-chains exists for considerably larger industries, the long-term viability and resource sustainability is threatened by periodic long-term droughts. Inappropriate drought management will seriously damage the land and natural resources of farms and may lead to a loss of breeding stock which in turn reduces the capacity of goat producers to recover after a long-term drought.

Current drought feeding and water supply recommendation for goats in Australia are out of date. Application of inappropriate drought strategies may endanger the welfare of significant numbers of goats. Many goat managers were not in the industry during the last long-term drought. It is appropriate for goat drought feeding recommendations to be reviewed.

With the impact of the current drought expanding, the goat industry requested that a review of existing material relevant to Australian conditions be prepared as soon as possible.

The key areas reviewed in this report were:

- the energy and water needs of goats;
- appropriate feeding systems and ration formulation; and
- the welfare of goats.

This project was funded mainly from industry revenue that is matched by funds provided by the Federal Government. The Specialised Rural Industries Program of the Victorian Department of Natural Resources and Environment also provided part funding.

This report, a new addition to RIRDC’s diverse range of over 900 research publications, forms part of our Rare Natural Fibres R&D program, which aims to facilitate the development of new and established industries based on rare natural fibres.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/reports/Index.htm
- purchases at www.rirdc.gov.au/eshop

Simon Hearn
Managing Director
Rural Industries Research and Development Corporation
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Previous colleagues Mr Brendan Scott, Mr Brian Hester and Ms Tracie Storey (McCallum), who assisted me during the 1981-1983 drought, are acknowledged for the large amount of extra work that was undertaken in often trying conditions. Dr. Russel Hodge, Dr Max Watson, Mr. Henry Birrell and Mr. Bob Bogdanovic are thanked again for their helpful drought feeding advice and for providing access to facilities during the 1980s that were outside the resources of the goat industry.

I also thank the goat producers who provided their views and experiences of drought feeding goats.

About the author

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Executive Summary

Introduction
Drought is a feature of the Australian farming landscape. The Australian goat industry has not previously reviewed the requirements and practices needed during drought feeding of goats.

Research objectives and general approach
This RIRDC supported project (DAV 202A) was titled “Objective drought feeding guidelines for caprines”. The project was divided into three stages. The outcomes for this stage provided:
1. A technical review of nutritional research relevant to the drought feeding of Australian non-milch goats; and
2. A concise summary suitable for goat producers.

The following general process was carried out:
1. Advising agents, producers and staff operating with the goat industries of the project and seeking their views and input on the work.
2. Reviewing published material relevant to the energy and water needs, appropriate feeding systems, ration formulation and welfare of goats.
3. Canvassing the wider goat industry to locate unique approaches to the drought feeding of goats in an attempt to capture and evaluate the generative learning of experienced goat producers.

Outcomes and implications of review
This review has identified and developed information for the best practice of goats during drought. Wherever possible reference has been made to original scientific data. Where relevant data are available for goats, the recommendations provided often differ to those provided for sheep. This project has enabled the first interim determination of critical live weights for goats. Where relevant data for goats are not available, the work relies on research undertaken with sheep.

The review has updated and revised the energy requirements for goats for maintenance and growth based on published and unpublished research with Australian goats. A number of useful existing and potential practices for improving the nutritional management and welfare of goats during drought have been identified. The impacts of cold and heat stress on the energy requirements of goats have been reviewed. Research on water requirements of goats has been summarised. Welfare requirements of goats during drought have been briefly reviewed.

The review has identified a number of deficiencies in knowledge regarding best practice and welfare of goats during drought. The review does not claim to be exhaustive but presents as a manual containing a substantial amount of technical information pertaining to the drought management of Australian goats. There are a number of significant gaps in our knowledge that should be rectified and in some areas the suggestions need to be validated.

Recommendations
On the basis of the findings the following recommendations are made:
1. That the findings be published and made available to goat producers and advisory agencies.
2. That industry associations are encourage to link their internet sites to the drought feeding information on the RIRDC and DNRE internet sites.
3. This review should be revised when the current long-term drought is broken.
4. That validation of unpublished information is undertaken.
5. Investigate a number of important areas impacting on drought management of goats.
1. Introduction

1.1 Background

1.1.1 Preparing for drought

1.1.1.1 Major issues
The major issue with managing goats in drought is a lack of understanding of their nutritional needs. This may be exacerbated when a deteriorating financial situation for the farmer occurs concurrently with the drought and conflicts with animal husbandry priorities.

The key issues associated with drought management are planning ahead and forecasting to anticipate stock and pasture condition and water availability. Key decisions that will need to be made by the farmer are whether to feed, agist or sell the stock. Clear guidelines for scoring body condition of stock are thus required. The interactions between economic viability, stocking rate, land degradation and animal welfare are complex and conflicting. The last resort “that it’s cheaper to let them die in the paddock” contravenes cruelty legislation and Codes of Practice. It is unacceptable to let goats die or suffer during drought.

1.1.1.2 Drought strategies
All farmers need to prepare for drought. For drought strategies to be successful, they need to be flexible. They need to be capable of being implemented and varied according to the severity and duration of the drought. Livestock producers have a range of drought strategies including:
1. feeding all the stock on the property;
2. culling and selling some stock;
3. agisting stock on another property;
4. selling all the stock.

Most goat farmers use option 2. Option 2 reduces the costs of feeding and avoids expensive purchases of replacement stock when the drought ends. This project is primarily concerned with feeding goats during drought.

Which goat to cull
Goat farmers have reported a range of drought culling practices. These include culling:
- non-breeding goats including wethers;
- does with no kids, poor teeth, udder faults, feet faults etc;
- shy feeders;
- cross-bred and feral types;
- saleable goats.

Most goat producers aim to keep their breeding flock substantially intact so they can recover their stock numbers as rapidly as possible when the drought breaks.

1.1.1.3 National Vendor Declaration
When any goats are sold, a National Vendor Declaration must be completed. A copy of the most recent NVD and instructions for its use are included in Appendix 2 of this report.

1.1.2 Justification for investigation
Current drought feeding and water supply recommendation for goats in Australia are not based on scientific knowledge of the energy and water requirements of goats. Many goat managers were not in the industry during the last long-term drought (1981-1983). Since this time there has been a number of scientific investigations into the nutritional and management needs of Australian goats. It is appropriate that the application of this knowledge be directed to providing the best drought strategies to reduce the impact of the drought on the welfare of goats and the financial and social stress on families.
While goats have generally similar energy requirements to sheep of similar live weight under calm conditions, there is objective evidence that the appropriate ration formulation, performance under non-grazing conditions, responses to grain feeding, welfare needs, and requirements under adverse climatic conditions differ significantly from ovine and bovine species. It is time for appropriate drought feeding recommendations to be developed taking into account:

- Published Australian nutritional experiments undertaken since the early 1980s;
- Unpublished relevant Australian wheat and drought feeding experiences with goats;
- Publications on the effect of adverse weather on the energy requirements on goats.

With the impact of the current drought expanding, the goat industry regards this work as a high priority.

1.1.3 Current industry practices

Benefits from the application of this work should include: less resource damage during droughts as a consequence of more appropriate use of pastures, grain, and water resources; increased capacity of goat producers to rebuild herds and become more productive after a long-term drought; improved welfare of goats with less deaths from acidosis and bullying; and more confident and capable farmers using appropriate science based industry resource materials.

1.2 Project Objectives

This RIRDC supported project (DAV 202A) was titled “Objective drought feeding guidelines for caprines”. The project was divided into three stages. The outcomes for Stage 1 were to provide:

1. A technical review of nutritional research relevant to the drought feeding of Australian non-milch goats;
2. A concise summary suitable for goat producers.

1.3 Project Methodology

1.3.1 Introduction

The following general process was outlined in the original submission and was carried out: Stage 1; Review. This component included:

1. Advising agents, producers and State Government staff operating with the goat industries of the project and seeking their views and input on the work.
2. Reviewing published material relevant to the energy and water needs, appropriate feeding systems, ration formulation and welfare of goats and bring the data together in a new technical document.
3. Canvassing the wider goat producing industry to locate unique approaches to the drought feeding of goats in an attempt to capture and evaluate the generative learning of experienced goat producers.
4. Providing this new “Interim” Technical Review to RIRDC for preparation into a pdf format for their internet site and a summary producer bulletin prepared for distribution via industry networks and the DNRE internet site.
5. Encouraging industry associations to link their internet sites to the drought feeding information.

1.3.2 Literature review

Research databases have been searched in an attempt to find scientific and other publications on the subject. Databases searched include Agricola, Australian Bibliography of Agriculture and CAB Abstracts. Few relevant articles on drought feeding were found.

This review includes data available from previous research from RIRDC funded projects, a recent scientific review that summarises relevant work of other scientists, and other articles considered relevant to the topic. Relevant information from Government Departments of Agriculture has been included, particularly information on the strategies for managing animals and from the Victorian Department of Natural Resources and Environment publication on drought feeding (Court 2002). Chapter 7 is substantially taken from Court (2002).
This review does not claim to be exhaustive. It has been prepared under tight deadlines at short notice. Drought feeding and management are complex issues and so the reader is directed to other sources for information on many issues that are outside the scope of this work. It was not possible to cover the many articles in the literature on the drought feeding of sheep that may be relevant to this topic. I have used my research wherever possible, partly because much of it has been focused on managing goats during dry summer droughts and secondly it was readily available and understood.
2. Droughts

2.1 Introduction

2.1.1 Scope of review

The recently revised Australian Goat Notes (Simmonds 2001), provides a wealth of valuable information for potential and current goat managers. The advice it contains on drought feeding goats (McGregor 2001a) is based on an article published two decades earlier during the 1982 drought (McGregor 1982). Indeed the international scientific literature on goat nutrition rarely mentions drought feeding requirements for goats. For example, a major international conference on Goat Nutrition, co-hosted by the Food and Agricultural Organisation, fails to mention the subject of drought (Morand-Fehr 1991). This contrasts with the authoritative textbook on Australian pastoral industries (Alexander and Williams 1973) that mentions drought on page 15!

Since the early 1980s there has been considerable progress in understanding both the nutritional requirements of Australian goats and on the best strategies for feeding and managing goats during drought.

This review aims to bring together scientific data relevant to the energy and water needs, appropriate feeding systems, ration formulation and welfare of Australian goats in relation to drought management of goats. This review also draws upon the currently published drought feeding and management recommendations provided by Government Departments for sheep (Court 2002) and goats (Scarlett 2002). This review also draws upon data available from previous RIRDC funded research projects, and on some unpublished experiments that are considered relevant.

2.1.2 Droughts and goats in other countries

A search of Agricola and CAB abstract databases revealed less than 15 articles mentioning goats and drought. Articles from South Africa, Morocco, Botswana, Kenya, Zimbabwe, Brazil and Trinidad and Tobago made a connection between drought and goat production. Few had any relevance to Australia. A report from Brazil was of interest. Gutierrez et al. (1985) studied the strategies of goat producers in a semi-arid region of northeastern Brazil for coping with drought. They observed that small-scale farms with cattle, sheep and goat herds performed relatively better during the drought period of 1981 to 1983 than farms with cattle and sheep only. Even though cattle production was the most important component of overall farm production and income, sheep and particularly goat production appeared to guarantee survivability to the producer by adding flexibility to the system when drought occurs.

2.2 What is a drought?

2.2.1 Many ways of defining drought

Droughts are recurring features of Australian climatic variation. Droughts have been defined as a “situation where the supply of water falls below critical demand; and as the demand is generally a function of man’s activities drought can be considered to be man made” (Gibbs and Maher 1967). There are many other definitions of drought and readers are referred to Anon (1990).

In Australia, the majority of farmed goat grazing occurs on grasslands, either improved or native, which exhibit very seasonal patterns of pasture growth (growing seasons commonly of 5 to 8 months). Mean annual rainfall in the wheat-sheep zone varies from 400 to 750 mm. Usually growing seasons extend from mid autumn to late spring although in northern parts of the wheat-sheep zone summer rainfall predominates.

Williams (1973) did not regard these extended periods of absence of rain as drought. The so-called “dry season” of the tropical north and the dry summer conditions referred to above are seasonal droughts at best, as the pasture system remains dormant until the next growing season commences. However few droughts are completely rainless. According to Williams (1973), “feed shortages which seriously
disrupt animal production generally have their origins in the rainfall and pasture growth of the preceding season”. For example, the drought of 1981 to 1983 in southern Australia, began with below average rainfall in the spring of 1981, restricting spring pasture growth. This was followed by below average rainfall during 1982, producing a “green drought” during winter and spring. Thus there was little feed in storage and reduced summer pasture residues. In this case there was also reduced water run-off leading to very low levels of water supply in the summer of 1982-1983.

Sturgess (1973) defined drought in a more management orientated way as “any period in which supplementary feeding at a defined level is necessary as a result of adverse seasonal conditions. The severity of the drought is indicated by the quantities of fodder it is necessary to feed, while the length of the drought is the period between the commencement and conclusion of hand-feeding”.

Sturgess’s definition of drought clearly includes seasonal droughts if supplementary feeding was considered necessary as well as the longer-term periodic droughts.

**2.2.2 What is the “normal” seasonal pattern of sheep live weight loss?**

An unstated assumption in discussions of drought feeding is that animal live weight change and welfare is well understood. William’s view is that normal seasonal changes are not classified as drought whereas Sturgess view was that if supplementary feeding is necessary owing to adverse conditions then drought management is required. So what are the normal seasonal changes in sheep live weight during summer? A brief review of sheep stocking rate experiments provides some data.

In southern and southwestern Australia and in the wheat sheep belt, seasonal droughts are usually experienced annually. Over a 12 to 16 week period in the summer, a 25 to 30% loss of live weight in sheep appeared to be normal (Brownlee 1973, Birrell et al. 1978, Egan et al. 1977, Davis et al. 1973, McGregor 1985b,c). Such a weight loss occurred before the critical live weight was obtained in sheep (see Section 3.2.1 for a discussion of critical live weight).

![Figure 1](image.jpg)

**Figure 1.** The changes in live weight of Angora wethers (castrated male) goats grazed on annual pastures in southern Australia and weighed every month from 10 to 75 months of age. Annual maximum live weights were reached at the end of spring or in early summer.

Figure 1 shows the pattern of live weight change of Angora wether goats grazing annual temperate pastures near Melbourne, Victoria (37°54’S., 144°41’E., elevation 46 m, mean annual rainfall 520 mm, adapted from McGregor 1998). The peak annual live weight occurs at the end of spring, usually in early summer. The animals then experience live weight loss as the hot summers and autumns are characterised by declining quantities and qualities of mature dead pasture residues. It has been known for many years that these pasture residues are deficient in both energy and nitrogen resulting in loss of live weight and declining fibre production of sheep grazing such pastures (Donald and Allden, 1959).
In three successive years these goats experienced live weight loss during summer and autumn for periods of 5, 7 and 4 months, resulting in loss of live weight equivalent to 14%, 21% and 20% of the previous maxima respectively. These periods of live weight loss are typical unless supplementary feed is provided. In these environments there are no or few browse plants available as alternative feed sources. In this environment maintenance of live weight is rarely observed.

Figure 1 also shows the impact of a long-term drought that extended from 12 to 32 months of age. The first spring appeared normal enough but the following winter and spring exhibited poor animal growth. The second spring was shortened (months 24 to 26) followed by four months of rapid live weight loss. There was then a two-month period of constant live weight as the goats were removed from the pastures and fed to maintain live weight. Animals at higher stocking rates received significantly more feeding over much longer periods.

2.2.3 Drought, stocking rate and grazing goats

2.2.3.1 Impact of stocking rate of goats and sheep
Drought is inevitability associated with stocking rate. A decision to increase stocking rate increases the severity and onset of drought, until, at very high stocking rates, drought can be continuous (Sturgess 1973).

In the study of McGregor (1985b,c) conducted on annual temperate pastures, goats and sheep were grazed at a range of stocking rates in separate goat and sheep pastures and when mixed together in equal numbers. During the course of this study a long-term drought was experienced (1981-83). As expected, it was observed that when the stocking rate of goats and sheep grazing annual pastures was increased, the amount of supplementary feeding necessary was increased. However, separately grazed sheep required significantly more supplementary feeding than separately grazed goats as the pasture grazed by the goats had significantly more herbage available at the start of the drought period. Indeed, sheep grazing with goats on the mixed grazed pastures required significantly less supplementary feeding as they were heavier than separately grazed sheep and took longer to reach critical live weights than separately grazed sheep at the same stocking rate.

One of the reasons that supplementary feeding began later in the drought on the pastures grazed only by goats was also the ability of the goats to utilise more of the paddock feed (McGregor 1985c). Thus using the definition of drought provided by Sturgess, the drought period was less for separately grazed goats compared with the sheep.

2.2.3.2 Impact of mixed grazing and stocking rate of goats and sheep
In the study of McGregor (1985b,c), goats and sheep were grazed at a range of stocking rates in separate goat and sheep pastures and when mixed together in equal numbers. At the recommended stocking rate, goats grazed with sheep had similar requirements for supplementary feeding as the sheep but their requirements were greater compared with the goats grazed separately at this stocking rate. When the stocking rate was 25% above the long term recommended level, the drought feeding requirements of goats mixed grazed with sheep were 50% greater than the requirements of the sheep grazing these pastures. This increased requirement reflected the reduced ability of the goats to compete with the sheep under conditions of reduced herbage availability at this high level of stocking rate. As a consequence the goats reached critical live weights earlier than did the sheep.
3. When and how to drought feed

3.1 Introduction

The decision to begin drought feeding needs to be part of detailed drought planning. Some of the planning issues are discussed later in this report. Further details on drought planning can be found elsewhere (eg. Court 2002, Anon 2002, AgNSW 2002). This review is written on the understanding that the decision has been made to provide drought feeding to goats.

The commencement and cessation of feeding, the level of supplementation and the introduction strategy are important components of drought management. Feeding too early or for too long can waste feed while commencing too late or stopping too soon can result in stock illness or deaths. Often the largest stock losses occur after the drought has broken, especially if the weather turns cold.

3.2 When to start feeding

Feeding should be started well before the goats reach their critical weight when they become weak. It may take some time before they become accustomed to hand feeding and begin eating their ration. If goats have lost too much condition before feeding has begun, or before they readily accept grain, it may be hard to lift their live weight back to desirable levels. This is particularly applicable to kids or weaners that were not fed supplements when grazing with their mothers.

It pays to remember that, unlike fire or flood when goats may have to suddenly rely on hand feeding alone, the onset of a drought is usually gradual. Thus drought conditions rarely start when no grazing is available and goats have to initially rely solely on hand feeding. Experience from previous droughts indicates that more paddock feed is available than would first appear. Goats can scavenge quite a bit of feed from sparse, dry pasture, weeds, dead leaves, low browse and buried clover or medic burr. The presence of paddock feed early in a drought makes it easier to get the goats accustomed to the drought rations before they have to be fed close to full rations. The nutritive value of this scavenged feed is discussed later in this report.

3.2.1 Critical live weight for goats

The critical live weights for different goat breeds have not been defined. This section estimates the critical live weights for Australian fibre and meat goats. The results are summarised in Table 3.3.

3.2.1.1 Critical live weight - the concept

The idea of a critical live weight for drought feeding is based on observations of animals in a drought. Grazing animals can lose 20 to 30% of their peak spring live weight and still be active. However further live weight loss may endanger the survival of the animal by leaving them too weak to walk, graze or safely obtain drinking water. The concept of critical live weight was developed to indicate the minimum live weight that will enable an animal to survive. The critical live weight is also used when determining feeding level and for long term budgeting and purchasing of feed.

Oddy (1978) provided a guideline to the critical live weight for various breeds and strains of sheep. His Table 11 is for fasted live weight and for sheep less the weight of fleece. Given that sheep may lose 2 kg in an overnight fast and making an allowance of 3 kg for greasy fleece weight (approximately the amount of wool grown between mid-spring shearing and late summer when drought feeding may commence), the information in Table 3.1 can be calculated.

3.2.1.2 Critical live weight and standard reference weights

Ideally, the critical live weight of goats would represent a proportion of the goats ultimate mature size. The concept encounters the problem of deciding when the mature size is reached and in accounting for the difference between sexes. The normal approach is to nominate a body condition score associated with the age and live weight of the animal. For sheep, SCA (1990) defined the concept of Standard Reference Weights (SRW, kg) as the live weight achieved when the animals...
skeletal development is complete and the empty body contains 250g fat/kg. For sheep this is achieved at a body condition score of approximately 3. Wether sheep have a SRW 20% higher and rams have a SRW 40% higher than ewes (SCA 1990).

The relationship between Oddy’s (1978) suggested critical live weights (fleece free) and the SRF was calculated (Table 3.2) and the value ranged between 58 and 66% of the SRF. The variation in this ratio may be related to the mature live weight of the breed and perhaps some disagreement between the sources as to the mature weight of the sheep. The average value of this ratio was 63%.

### Table 3.1 Guideline to critical live weights for various breeds and strains of sheep #. These live weights are off pasture with an allowance for fleece growth equal to half of a shearing interval. Values for sheep from Oddy (1978)

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</tr>
<tr>
<td>Medium-framed Merino/Polwarth</td>
<td>40</td>
<td>37</td>
</tr>
<tr>
<td>Large-framed Merino</td>
<td>45</td>
<td>42</td>
</tr>
<tr>
<td>Corriedale</td>
<td>45</td>
<td>42</td>
</tr>
<tr>
<td>Border Leicester-Merino cross</td>
<td>50-55</td>
<td>48</td>
</tr>
</tbody>
</table>

# All values are provided for guidance purposes only. It is the responsibility of owners to ensure that sheep are managed in accordance with the Code of acceptable farming practice for sheep

### Table 3.2 Comparison of critical live weights of sheep (Oddy 1978) with Standard Reference Weights for castrated males (SRW) or different breeds or stains of sheep (SCA 1990). Critical live weights (CLW) equal critical fasted fleece free live weight plus 2 kg (Oddy 1978)

<table>
<thead>
<tr>
<th>Breed or strain</th>
<th>SRW, kg</th>
<th>CLW, kg</th>
<th>CLW/SRW, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angora goats</td>
<td>47</td>
<td>30</td>
<td>66</td>
</tr>
<tr>
<td>Small-framed Merino</td>
<td>48</td>
<td>32</td>
<td>66</td>
</tr>
<tr>
<td>Medium-framed Merino/Polwarth</td>
<td>60</td>
<td>37</td>
<td>62</td>
</tr>
<tr>
<td>Large-framed Merino</td>
<td>72</td>
<td>42</td>
<td>58</td>
</tr>
<tr>
<td>Corriedale</td>
<td>66</td>
<td>42</td>
<td>64</td>
</tr>
<tr>
<td>Border Leicester-Merino cross</td>
<td>66</td>
<td>42</td>
<td>64</td>
</tr>
<tr>
<td>Average value for sheep</td>
<td></td>
<td></td>
<td>63</td>
</tr>
</tbody>
</table>

# CLW calculated from SRW of wethers using the average ratio of 63% derived from sheep

#### 3.2.1.3 Critical live weight of goats – seasonal peak method

McGregor (1985c and unpublished) calculated a critical live weight (CLW) of Angora goats as:

\[ \text{CLW} = 70\% \text{ of the peak live weight at the end of the spring plus 1 kg for each year of age of the goats plus estimated greasy fleece weight.} \]

The use of a 30% reduction in peak spring live weight was based on the typical changes observed in annual live weight patterns with sheep (section 2.2.2). In this instance the goats were 2½ years of age and the calculated critical live weights ranged from 20 to 24 kg depending on the stocking rate during the previous spring. The use of 20 kg as the critical live weight was practical and enabled the Angora wether goats to survive the drought.

#### 3.2.1.4 Critical live weight of Angora goats – standard reference weight method

The maximum mature live weight that the Angora wether goats reached in this grazing experiment was 54 kg (McGregor 1989 unpublished). The live weight when these Angora wether goats reached a total body fat content of 250 g fat/kg was approximately 47.5 kg if an allowance for the fat content of all non-carcass tissues is made (McGregor 1992a).
Applying the average ratio of CLW/SRW for sheep from Table 3.2, provides an estimated CLW for adult Angora wethers of:
\[
CLW = 0.63 \times 47.5 \text{ kg} \approx 30 \text{ kg}
\]
An allowance must then be made for fleece weight (assuming 2 kg). Thus does have a CLW of 27 kg, wethers of 32 kg and bucks of 37 kg.

### 3.2.1.5 Critical live weight of other goat breeds – standard reference weight method

#### Cashmere goats
There is insufficient information about the total body fat content for cashmere goats to enable an estimate of the live weight when this breed would reach 250 g fat/kg of total body weight.

Cashmere type goats are regarded as being leaner than Angora goats but there is no carcass composition evidence to support any determination. Five-year-old Australian cashmere wethers have reached a mean live weight of 60 kg with a body conditions score of 3 (McGregor 1990b). Using this live weight a CLW can be estimated for wethers as
\[
CLW = 0.63 \times 60 \text{ kg} \approx 38 \text{ kg}
\]
Using an allowance for fleece weight (assuming 0.5 kg) and adjusting for the sexes provides a CLW for does of 32 kg, wethers of 38 kg and bucks of 45 kg.

#### Boer goats
Campbell (1981) regarded the mature live weight of the Improved Boer Goat as 100 kg for males. These animals are likely to have had a body condition score in excess of 4. The body composition of 12 well fed Boer goat does between the live weights of 18 to 59 kg were reported by Viljoen et al. (1988). An analysis of the data for this review indicated that at about 55 kg live weight a total body fat composition of 25% was reached. This is in general agreement with unpublished field work (McGregor 2001), where in a flock of Boer goat does the mature weight for Boer females at a condition score 3 was approximately 60 kg. Using the former live weight, a CLW can be estimated for does as:
\[
CLW = 0.63 \times 55 \text{ kg} \approx 35 \text{ kg}
\]
With no allowance for fleece weight and adjusting for the sexes provides a CLW for does of 35 kg, wethers of 42 kg and bucks of 50 kg. Clearly there are larger individual Boer goats, but the reader must remember that the CLW is derived to assist management of a large herd of these animals and the critical live weight is used to a guide as to the minimum weight to be reached during a drought.

### Table 3.3 Guideline to critical live weights for breeds of goats based on estimates of standard reference weights or by the use of the seasonal peak live weight method. These live weights are off pasture with an allowance for fleece growth equal to half of a shearing interval

<table>
<thead>
<tr>
<th>Breed of goat</th>
<th>Critical live weight, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Does</td>
</tr>
<tr>
<td><strong>Standard reference live weight method</strong></td>
<td></td>
</tr>
<tr>
<td>Angora goats</td>
<td>27</td>
</tr>
<tr>
<td>Cashmere goats</td>
<td>32</td>
</tr>
<tr>
<td>Boer goats</td>
<td>35</td>
</tr>
<tr>
<td><strong>Seasonal peak live weigh method</strong></td>
<td></td>
</tr>
<tr>
<td>All breeds</td>
<td>30 % less than previous peak live weight plus 1 kg for each year of age plus estimated fleece weight</td>
</tr>
</tbody>
</table>
3.2.2 Body condition score for goats
3.2.2.1 Body condition scoring for goats – the concept
Body reserves of goats are an important source of energy during critical stages of production and during drought. An accurate assessment of body reserves is therefore important for optimising nutritional management (SCA 1990) as live weight alone can be difficult to interpret owing to differences between the mature size of animals and strain of animal. Goats can also use body energy reserves and maintain live weight (McGregor 1988) by retaining increased amounts of water.

In association with live weight, the body condition score of the goat should be taken into account during drought feeding and management. Using the body condition scoring techniques first described for sheep by Jefferies (1961), recommendations have been made about its application for goats (McGregor 1983, 1984a, 1988, 1992a, 1995, Mitchell 1986). Further details about body condition scoring can be obtained in more recent publications (Anon 2001, McGregor 2002a).

3.2.2.2 Relationship between body condition score and tissue reserves in goats
The body and tissue reserves of Australian cashmere and Angora goats with low body condition scores are lower than goats with higher body condition scores (McGregor 1990b, 1992a). There is an association between live weight and body condition scores in goats. As goats increase in live weight, their body condition scores tend to increase and as goats lose live weight their body condition scores tend to decrease.

Over a period of years a goat may experience an increase and a decrease in its body condition score (McGregor 1985 unpublished data). Within a mob of goats, it is usual for there to be a range in body condition scores.

3.2.2.3 When to start feeding based on body condition scores
Supplementary feeding should begin when half the goats in a flock have fallen to a body condition score of low 2 (2-, lean or backward store) or below. Feeding should be increased until half a maintenance ration is fed (see Chapter 4). If body condition continues to fall, lift the feeding rate until body condition is maintained. Stop feeding when only a quarter of the stock remain at a body condition of 2- or less after a drought has broken.

3.3 How to start feeding goats
3.3.1 Controlled live weight loss
Adult goats above the critical live weight, can be allowed to lose some weight and condition at the start of a drought. This weight loss should be controlled. A drop in weight of 4 kg over a number of weeks and a drop back to store condition will save a lot of feed over the drought feeding period.

In drought feeding situations it is best to start feeding animals before they reach the critical live weight. If you start feeding when the goats are 3 kg above the critical live weight, the goats can lose weight during the introductory period without drastically altering their chances of survival. This period of controlled weight loss can coincide with the feeding of introductory rations. The flock can safely lose 1 kg on average a week for this period (McGregor 1985b,c).

3.3.2 Introduction to grain
3.3.2.1 Gradual introduction method
Goats have to be brought gradually onto cereal grain such as wheat, barley, triticale, maize, sorghum and commercial pellets or “sheep nuts” or any ration that is high in starch and low in fibre. The gradual introduction is required as a sudden change in diet can cause grain poisoning or acidosis. This disease is discussed in Chapter 7. It is best to introduce goats onto cereal grain while there is still reasonable paddock feed available.
Train goats that have not been fed grain before by including previously fed goats in the mob to encourage the inexperienced goats to feed. Untrained goats are best educated in small paddocks. It is likely that 10 to 20% of goats will be shy feeders when wheat is introduced (McGregor et al. 1994). The feeding of whole grain lupins to goats without experience of lupin grain resulted in a high incidence of non-eaters and in these circumstances the feeding of wheat for rapid intake of energy appeared more desirable than rapid introduction of lupins (McGregor et al. 1994). Gherardi and Johnson (1994) observed that when feral goats were introduced into a feedlot and introduced to shipper pellets over three days, by the replacement of hay with pellets, the incidence of shy feeders ranged up to 30%. Many goats lost more than 20% of their entry live weight within 7 to 14 days.

New kids can be taught to accept hand feeding before weaning by learning from their mothers to accept grain. In a drought feeding situation this means that at least twice before kids are weaned that does should be fed grain.

When starting to feed inexperienced goats, use good-quality hay and spread it over a large area so it is accessible to all the goats at the same time. This is best done in a small paddock or large yard that has good shade and water but no available grazing (Scarlett 2002). When the goats are used to eating the hay, begin grain feeding by pouring measured amounts of grain over newly feed of hay. Gradually increase the grain ration at each feeding as discussed below. Hay feeding can stop when the goats are used to eating the grain.

The cereal grain ration should be started at the rate of 50 grams per head per day for adult goats, (25 grams for weaners) and increased slowly until the required ration is reached (see Table 3.4). This feeding and introduction program has been successfully used without problems for the feeding of wheat, barley and oats with a variety of Australian goats (McGregor 1995, 1998 and unpublished; McGregor and Hodge 1988, 1989, 1996; McGregor and Umar 2000).

More rapid introduction of cereal grains can induce acidosis. For example, when ground barley (73.5%) and crushed lupins (24.5%) and mineral supplement (2%) was fed as pelleted diets and introduced to full feeding over a 10 day period, acidosis was exhibited by 80% of goats in the first week as shown by bouts of feed rejection (McGregor 1994, see also McGregor and Howse 1996). Norton (1982) reported that 20% of feral goats offered a concentrate diet with 18% crude protein showed persistent diarrhoea but the feeding method was not described.

Once the required feeding rate is reached (Table 3.4), the introduction program can stop. So, if the target is feeding 300 g of cereal grain per day, this will be reached on day 11.

**Table 3.4 A guide to the introduction of cereal grain to goats**

<table>
<thead>
<tr>
<th>Feeding days</th>
<th>Feeding frequency</th>
<th>Amount of grain per feed</th>
<th>Amount of ground limestone per feed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>gram per goat per day</td>
<td>kg per 100 goats per day</td>
</tr>
<tr>
<td>1, 2</td>
<td>feed daily</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>3, 4</td>
<td>feed daily</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>5, 6</td>
<td>feed daily</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>7, 8</td>
<td>feed daily</td>
<td>200</td>
<td>20</td>
</tr>
<tr>
<td>9, 10</td>
<td>feed daily</td>
<td>250</td>
<td>25</td>
</tr>
<tr>
<td>11, 12</td>
<td>feed daily</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>13, 14</td>
<td>feed daily</td>
<td>350</td>
<td>35</td>
</tr>
<tr>
<td>15, 16</td>
<td>feed daily</td>
<td>400</td>
<td>40</td>
</tr>
<tr>
<td>17, 18</td>
<td>feed daily</td>
<td>450</td>
<td>45</td>
</tr>
<tr>
<td>19, 20</td>
<td>feed daily</td>
<td>500</td>
<td>50</td>
</tr>
<tr>
<td>21, 22</td>
<td>feed daily</td>
<td>550</td>
<td>55</td>
</tr>
<tr>
<td>23, 24</td>
<td>feed daily</td>
<td>600</td>
<td>60</td>
</tr>
<tr>
<td>25, 26</td>
<td>feed daily</td>
<td>650</td>
<td>65</td>
</tr>
<tr>
<td>27, 28</td>
<td>feed daily</td>
<td>700</td>
<td>70</td>
</tr>
</tbody>
</table>
Oats and lupins have a higher fibre content than the other grains and the full rations recommended may therefore be built up more quickly over a period of from 14 to 21 days with less risk of causing digestive upsets. However it is suggested that the more cautious approach be applied for the introduction of all grains by following the guidelines for cereal grains unless more pressing welfare needs have been identified. One reason for this suggestion is that the energy content of oats varies throughout the cropping districts in Australia. If you are unsure of the energy content of your oats, then adopt the cautious approach or confirm the energy content by testing.

3.3.2.2 Modification during the introduction period
In the early stages of grain feeding it is unwise to progress to higher levels of feeding until nearly all of the goats have taken to the ration or shy feeders have been drafted off. In group feeding situations, gorging is likely to occur (McGregor et al. 1994), especially since a substantial proportion of animals (10 to 20%) could be non-eaters. This is more likely to occur at the 2 to 3 week stage when the total amount of grain being fed is becoming more substantial.

If many cases of grain poisoning occur, particularly at the 2-3 week stage, the program should be modified by not increasing the ration for a few days and providing roughage (hay). For example McGregor (1984b) found when 20 kg goats were introduced to whole barley (75%) and whole lupin (25%) grain, that signs of grain poisoning appeared (as shown by rapid loss of appetite) during week 3 of the program. The provision of a small amount of hay was associated with a rapid return of appetite.

3.3.3 Provision of hay or roughage
3.3.3.1 Quantities of roughage to feed
Goats can be adequately fed to maintain live weight on diets of barley (75%) and lupins (25%). McGregor (1983 unpublished) has examined the feeding of wheat in simulated drought conditions when roughage may be unavailable or its use limited by its high cost. Preliminary evaluation of the data suggests that drought rations consist of 30% roughage to ensure that all goats consume sufficient whole wheat grain to enable maintenance of live weight and welfare. This implies that if no paddock feed is available during a drought, hay should be provided at 30% of the ration. However if higher nutritive value feeds are provided such as lucerne hay and or barley/lupin rations then the quantity of roughage can be reduced (see review McGregor 1998).

In practical terms, some goats can be fed diets consisting only of wheat grain without signs of illthrift or acidosis (McGregor et al. 1994). Thus when roughage may be unavailable or very expensive, it may be more cost effective to draft off the shy feeders and provide them with a ration of 30% roughage. The remaining goats may be fed less roughage. The use of ricehulls as a roughage source for goats is ineffective (McGregor 1991, McGregor and House 1996, see section 3.4.1.2). However, one must be vigilant that acidosis does not occur in the animals consuming 100% wheat grain.

In southern Australia during a dry winter, the feeding over four months of a supplement of 600 g/goat/day of lucerne hay in addition to the grazing allowance of sparse annual pasture did not increase the mohair growth of does. There was a slight increase in mohair growth to the feeding of barley grain at levels of 375 and 500 g/goat/day compared to the feeding of barley grain at levels of 250 g/goat/day or less, but the response was less than 10% additional mohair (McGregor 1995). The feeding of barley grain at 250 to 500 g/goat/day to does significantly improved the mohair style and mohair character scores and mohair length compared to does fed no grain or fed 125 g/goat/day of barley.

3.3.3.2 Fleece contamination from feeding roughage
When feeding hay, straw or grazing stubbles, the fleeces of Angora and cashmere goats can become contaminated with vegetable matter and dust. Severe price penalties exist once the VM levels exceed 1 to 2%. Stapleton (2002) reported he sometimes observed a large build up of fine straw particles and chaff in the fleece and soil penetrated the back-line of the fleece when Angora goats grazed stubble. While dusty mohair is not necessarily a problem it does show the kemp and there is a greater chance of classing fleeces into kempy lines. The dust content increases the wear of shearing equipment. For Angora goats it is advised to have an early shearing in February if you intend to graze stubble extensively.
3.4 Supplementary feeding and behaviour

3.4.1 Substitution

When grazing animals are offered supplements of grain or hay, the intake of pasture is usually depressed. The extent of the depression divided by the weight of supplement eaten is called the substitution rate (SCA 1990). Substitution rates of 1.0 occur with high quality supplements on abundant high quality pasture, but the rate may be as low as 0.65 on pastures with a digestibility of 50%. Substitution rates of 0 to 0.50 are predicted when pasture availability is less than 0.5 tonne DM/ha and will remain at about 0.45 when the digestibility of the pasture is less than 50% and the digestibility of the supplement is 80%.

For example Allden (1969) examined the response of 27 kg Merino weaner sheep during summer drought when grazing low quality herbage (> 2000 kg DM/ha) with a digestibility of 45 to 49%. For each 100 g of supplementary oat grain fed, the intake of herbage decreased by 65 to 69 g. The daily ME intake required to maintain the fleece free live weight of the grazing sheep was 602 kJ ME/kg0.75.

3.4.2 Feeding frequency and goat behaviour

The drought feeding strategy for sheep fed cereal grains is to change from daily feeding to feeding every second or third day (Court 2002) after following the routine in Table 4 for 2 weeks. Such a strategy is designed to reduce labour and to provide a mechanism to reduce the incidence of shy feeders (SCA 1990). The SCA concluded (SCA 1990, p. 229) that these advantages outweigh nutritional disadvantages for sheep and cattle. The practice of drought feeding sheep less frequently than daily originates from research conducted during the 1940s and early 1950s (Anon 1951) as Hewitt (1940) makes no reference to the practice.

When Farrell and Watson (1973) investigated the effects of feeding wheat daily or a similar amount in one feed per week, they found that the net availability of metabolisable energy (ME) was reduced with the once a week feeding regimen. This agrees with earlier theories and observations about the increased efficiency of utilization of the ration because of the reduced heat increment with daily feeding. Associated with the reduced feeding frequency of wheat were increases in water consumption (Watson et al. 1975), and a range of other changes in rumen and blood metabolites (Watson 1975). It would appear that for efficient use of feed ME and water resources, that once daily feeding is preferred over less frequent feeding regimens.

Experience has shown that when feeding full drought rations of cereal grains to goats when there is little or no roughage available it is best to feed each day. For example, attempts during the 1981-1983 drought to feed whole wheat to flocks of Angora goats indicated that the behaviour (dominance) of some goats contributed to grain poisoning (McGregor 1983 unpublished, McGregor et al. 1994). Attempts to feed less frequently than once per day were not successful, with some goats gorging wheat, resulting in subsequent severe acidosis.

Daily feeding can be achieved with a self-feeder or by feeding hay and grain on alternative days. Frequency of feeding can be determined by the state of the goats, type of feed, availability and capacity of troughs, and risk of feed losses through rain, birds and other animals.

It is possible to feed goats less frequently than 7 times per week when less than a full ration of cereal grain is fed and dry standing pasture residues are available or when low energy oats or other non cereal rations are being provided. For example, no problems were experienced when a ration equivalent to approximately 50% of maintenance energy requirements (equal to about 200 g/day per goat) was provided as five feeds each week (Monday to Friday) equal to 280 g/day per goat (McGregor 1992). The introduction program indicated in Table 3.4 should be followed.

Stapleton (personal communication 2002) introduces his goats to oats by starting with about 30kg per 100 does twice a week and over 2 weeks building up to about 40kg every second day. This is the equivalent to 300 g/goat at the start. Stapleton noted that some animals get a reaction to oats especially if they have run some distance to the grain. This response appears to be mild grain poisoning.
3.4.3 Feeding method, behaviour and fencing

Holst (1997) discusses a range of supplementary feeding systems and their efficiency of feed use. The design of feedlot facilities for goats is discussed elsewhere (Holst 2000).

3.4.3.1 Trails

The introduction ration may be fed out in thin trails so that it can be eaten along with paddock feed on the ground. Longer trails reduce the problems of dominance between goats (McGregor personal experience, Scarlett 2002, personal communications from farmers) but may increase feed wastage. Holst (2000) reported that 16% of lupins could be wasted when fed in trails. When forced to feed in confined spaces, goats invade the approach distance between animals and displays of butting and bullying are common. In poorly managed situations, some shy goats and less dominant animals will not receive any feed. Using very long thin trails providing at least 1 m per goats is suggested.

3.4.3.2 Behavioural problems, shy feeders and fences

Shy feeders are usually seen on the fringe of the general mob (Scarlett 2002). Shy feeders lose weight rapidly because they are not eating the ration provided. Shy feeders will not survive for long unless remedial action is taken. Scarlett (2002) suggested the following approach to minimise the number of shy feeders:

- Draft goats into groups of uniform size, weight and condition. Keep young goats separate.
- Limit the number in each mob, with full-grown goats in groups of 1000 or less, and kids and weaners in groups of 400 or less.
- Feed in areas that are visible to all goats. Paddocks with hills, gullies and patches of dense timber are unsuitable.
- Make the feeding trail as long as possible. A circular trail is preferable to a straight trail. If you are using troughing, make sure there is enough space for all goats to eat at once.
- Remove shy feeders and feed them separately with good legume hay. As consumption increases, gradually introduce grain until they are on the same routine as the main mob.

The introduction to full feeding from grain feeders needs to be done gradually. One grower reported that when a mob of 400 does, that were familiar with using a grain feeder, were introduced to full feeding 5 were trampled to death in the rush. This grower warns against using feeders unless producers have enough access so that all goats can stand and feed at the same time.

During drought feeding, a days ration of grain or even hay can be consumed in 15 to 30 minutes. Given that goats usually spend 8 to 9.5 hours grazing each day (McGregor 1982b and unpublished) and a similar amount of time ruminating, the provision of a days ration can lead to goats having plenty of time for exploration and misadventure. Growers have reported that does in good condition and receiving enough grain would still attempt to escape to the next paddock. The implication is that good fencing is required at all times, even during a drought. The authors experience of Angora and cashmere goat responses to fences is described elsewhere (McGregor 1990a). These observations include periods of intensive drought feeding (1981-1983) and numerous periods of supplementary feeding during dry summers. No case of goats escaping from one paddock into the next paddock to consume supplements was seen. In these cases the goats would all have been losing body condition and live weight and feeling the effects of drought conditions.

The most dangerous influence of fences during periods of feed shortage (summer or winter) is when goats push their heads through narrow spaces in prefabricated wire fences and are unable to withdraw their heads thereby becoming entrapped (McGregor 1990a). The implication is that goat producers need to inspect their fence lines regularly.

3.4.3.3 Super spreader

Feed can be distributed by using a super spreader, particularly for larger sized grain such as lupins and beans (Bell 2002). This approach will encourage foraging and is particularly useful when there is still pasture or crop residue available for animals.
3.4.3.4 Troughs and feeders
Rations can also be provided in metal troughs such as modified roofing or spouting as a way to minimize loss of grain into the soil caused by trampling etc. Troughs can become wet and any feed residue rapidly becomes mouldy. Troughs need to be cleaned prior to each feeding and emptied of any faecal matter, feed residue, water and urine.

The amount of feed intake can be more easily controlled by the use of a grain feeder designed with adjustable channel widths to control the delivery of grain, pellets, meal and hammermilled mixes. The Cowra Lick Feeder (Lachlan Steel Fabrications, Cowra) is one example of such a controlled feeder. The Cowra sheep feeder is 2.3 m long, double sided, built on skids, contains 17 bags of feed and retails for $968 inc GST. Clearly advantages of such a feeder include the reduced need to feed each day, less wastage, reduced disease transmission, reduced loss of feed from rain or birds but the disadvantage is the cost, especially if a number of feeders are required.

3.4.3.5 Using salt to limit intake
If supplements are provided in feeders without adjustable channels, feed consumption by goats can be limited by the addition of common salt (sodium chloride). Huston et al. (1971) reported that in rangelands in Texas the use of 20% by dry weight of salt or 10% gypsum limited consumption of Angora goats. Huston noted that the effects of feeding high levels of salt were still in question. They also noted that producers should experiment with other levels of salt in order to determine what level will satisfactorily limit supplement consumption under their conditions.

In South Africa, Van der Westhuysen et al. (1988) advised Angora goat producers that adding salt was an effective method of controlling the intake of supplements. They claimed that by gradually decreasing the salt content the intake of the supplement could be increased to the desired level. Thus in week one the salt content was suggested as 20%, declining to 10% by week three. This approach limited the intake of a supplement to about 200 g/goat/day. For kids and weaners a level of 10% salt was suggested providing 50 to 100 g/goat/day.

One problem may be the “top dressing” of the pasture by spreading salt over a property.

3.4.3.6 Feeding method and disease transmission
There may be an association between feeding method and disease transmission. This is discussed further in Chapter 7.3.

3.3.4 Mis-mothering during drought
During drought the mis-mothering of kids is likely to be increased. Mis-mothering will be worse in a paddock with timber belts or gullies or other areas where does (especially the maiden does) simply "forget" that they have planted their kids. One grower reported that they adopted a strategy of feeding out in early morning thereby maximising the time left for does to re-unite with their kids.

3.3.5 Breaking routine or changing feed
Experience with sheep suggests that if a break in the normal feeding routine occurs for more than 2 to 3 days through delay in the availability of supplies or other matters, feeding should not be resumed with the full ration when supplies become available. Begin feeding again daily on about half-rations, and build up to the full ration over a few days before returning to your previous routine (Court 2002).

It is especially important to avoid sudden changes in the ration. Goats that have become accustomed to one type of grain cannot immediately adjust to another. Deaths can result from a sudden switch of feed. Even the same grain type obtained from a different source has caused losses with sheep, presumably a consequence of higher digestible starch content in the new cereal grain (Court 2002). Hence, it is desirable to estimate early in the program how long supplies will last. This will allow time for planning of a gradual changeover from one feed to another.
In the 1982-83 drought, digestive problems often occurred when a new batch of sheep nuts was fed, even when the sheep had been well accustomed to the previous batch. Manufacturers sometimes change the major grain ingredients, or change the processing procedure, from one batch to the next (Court 2002). The list of ingredients on commercial sheep nuts can be used as a guide to what is in the feed but generally not the relative amounts of each ingredient.

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 over at least a week. Gradually changing the supplies of cereal grain and processed pellets or nuts fed to a range of goats has not caused any problems (McGregor 1984, McGregor et al. 1995).

Additions to the ration of 2% sodium bentonite or 1% salt may reduce the risk of grain poisoning during the change. Other approaches are discussed in the Section 3.4.

3.3.6 Feeding processed grain or hay

Feeding processed grain to goats can increase the incidence of grain poisoning and significantly reduce appetite (McGregor 1994, McGregor et al. 1994). When whole grain barley and oats are fed to goats there will be some loss of gain in the faeces (McGregor and Whiting 1990 unpublished). However the cost of processing by hammermilling, cracking, popping, rolling, grinding, or pelleting the grain are usually greater than the value of the “lost” grain. In addition, the increased risks of grain poisoning make processing of grain unattractive for drought feeding adult goats. For early weaned kids it may be necessary to process grains to enable kids to consume and digest sufficient amounts of grain. For example, during introduction to grain, barley may be cracked and lupins milled for creep feeding to weaners. Finally, animals that are on a reduced feed intake during drought conditions generally digest feed more efficiently than fully fed goats and the appearance of whole grains in faeces generally appears to be greater than it truly is.

Processing of hay and straw by hammermilling, pelleting or chaff cutting are also generally unnecessary. The ME value for fodder can be increased slightly by these processing systems (SCA 1990) but the costs usually out weigh the benefits.

3.4 Using additives to limit acidosis

3.4.1 The potential use of slaked lime

3.4.1.1 Twice weekly feeding of cereal grain

Wentzel (1982) described the use of caustic soda treated maize for supplementary feeding of goats and sheep to modify the process of rumen fermentation and limit rumen acidification. Subsequently Wentzel (1987) advised that the use of calcium hydroxide (Ca(OH)₂) treated maize with sodium monensin (Rumensin) for supplementary feeding cold stressed goats and for drought feeding small livestock was a safer and more cost effective approach. Owing to the brownish appearance of the end product, South African Angora goat and sheep farmers call such treated maize “chocolate mealies”.

Van der Westhuysen et al. (1988) indicated that using maize treated in this way the supplementation of 300 g/goat/day could be provided as two feeds per week. They reported that the feeding of 900 g of chocolate mealies on Day 1 followed by 1200 g on Day 4 (2 feeds per week) provided good results.

3.4.1.2 Very rapid introduction of cereal grain

Goats may require rapid introduction to high-energy cereal grains during adverse weather following shearing and after fires or flooding destroy pastures. In these circumstances there is no opportunity for a gradual introduction and the need to feed a maintenance or double maintenance energy ration significantly increases the risk of severe or fatal acidosis. In one experiment where individually fed Angora goats (mean live weight 40 kg) were offered 500 g/day of wheat without an introduction period, no mortality was reported over a five day feeding period and the average intake was 465 g wheat/goat/day (McGregor et al., 1994). This study recommended that the wheat be treated with slaked lime to increase rumen pH and so reduce the potential for acidosis.
An alternative strategy of using rice hulls as a cheap form of roughage with wheat (McGregor and Howse 1996) showed that:

- Goats showed a strong discrimination against rice hulls fed in a variety of loose forms. In the loose form rice hulls did not assist the adaptation to wheat diets. Intake of rice hulls was only 3 to 5 g/d.
- When rice hulls were incorporated into pellets with wheat at the rate of 30, 40 or 50% and the diets rapidly introduced, the pellets resulted in depressed feed intake compared with slaked lime treated wheat and a large increase in the number of shy eaters. There was no evidence that rice hulls increased rumen pH or modified rumen pH changes.

### 3.4.1.3 Australian experience with slaked lime

Australian research with goats fed 300 and 500 g/d of whole grain wheat without an introduction period showed that inclusion of slaked lime in whole grain wheat diets increased rumen pH when compared to diets without slaked lime (McGregor et al., 1994, McGregor and Howse 1996). The size of the effect increased with time. It was likely that, if greater amounts of treated whole grain wheat were fed, greater benefits in rumen pH would be detected closer to introduction. These results suggest that treating wheat with 2% slaked lime for rapid introduction to goats is a practical method for rapid introduction to high energy grains (McGregor et al. 1994).

In group feeding situations, gorging is likely to occur, especially since a substantial proportion of animals (10-20%) may be non-eaters. The increase in rumen pH with the addition of 2% slaked lime could well prevent acidosis and even death. Based on Australian and South African experience it is suggested that in group feeding situations that wheat and corn should be treated with 2% slaked lime.

### 3.4.1.4 Treating wheat with slaked lime

To use molasses as the binder:
Use a paddle mixer, mix whole grain with 2% slaked lime (Limil, David Mitchell Estates Ltd, 90% Ca(OH)$_2$) and 1.9% molasses (McGregor et al. 1994).

To use water as the binder and to add urea:
First thoroughly mix together: 3.6 l water, 1.4 kg urea, 2.8 l molasses, 2.2 kg slaked lime (Limil) for each 100 kg of grain. Then using a paddle mixer, mix whole grain with the prepared premix (Van der Westhuysen et al. 1988). If this mix is being fed to bucks or wethers it is advisable to add 0.5 kg ammonium chloride (NH$_4$Cl) to each 100 kg of grain.

### 3.4.2 Other additives

Wentzel (1982) and subsequently Van der Westhuysen et al. (1988) proposed the use of sodium monensin (20 ppm) to modify the process of rumen fermentation and limit rumen acidification when maize was fed to goats and sheep as two feeds per week. When Rumensin (17 ppm) was included in whole wheat fed to individually penned goats at intakes of 300-500 g/day over 4 or 5 day periods, the rumen pH was no higher than that provided by slaked lime, and less stable feed intake was observed (McGregor et al. 1994). Thus Rumensin provided no additional benefits over that provided by slaked lime and appeared unnecessary.

Thorniley et al. (1996) reported that a single drench of the antibiotic virginiamycin, can control acidosis in sheep and cattle. A single drench of 2.5 mg/kg live weight prevented mortalities in weaner sheep fed wheat ad libitum in pen conditions by suppressing rumen L-lactate levels for 4 to 5 days after treatment. Further research indicated that a single drench of 160 mg of virginiamycin (Thorniley et al. 1998) can effectively prevent lactic acidosis in sheep fed wheat diets.

Additions to the ration of 2% sodium bentonite or 1% salt may reduce the risk of grain poisoning for sheep during the introduction of whole wheat (Court 2002).

It was advised that ammonium chloride (0.5%) should be added to cereal grain to prevent formation of urinary calculi in males if fed more than 500 g/day of slaked lime treated grain (Van der Westhuysen et al. 1988).
3.5 Monitoring the goats

The management of goats during a drought depends on knowing how the animals are faring. The only real way to know how they are going is to weigh and condition score them. Tag or brand 20 goats from each mob and weigh them regularly throughout the drought. Knowing weight changes can save the cost of unnecessary feeding as well as preventing deaths of goats that slip too far before being fed, or which are not getting enough to eat. Producers are encouraged to body condition score these goats. It is possible for goats to maintain live weight but to lose body condition score during a long period of maintenance feeding (McGregor 1988).

A variable proportion of goats and kids will not adapt to drought feeding. The proportion of shy feeders depends on age, previous feeding history, ration, mob size (in sheep the proportion rises steeply once the mob size is above 400), but up to 10% is not uncommon. Remove shy feeders from the mob and feed them separately with good quality hay or sell them. Most shy feeders eat some of the ration but not enough to maintain their weight.

3.6 Deciding when to stop feeding

Droughts end after enough rain has resulted in pasture germination sufficient for supplementary feeding to cease. Often heavy rains are associated with the end of a drought. Scarlett (2002) advised that it was essential, to confine goats to feeding sites that are accessible by vehicle after rain. The alternative is to establish an emergency feed dump at the feeding site, preferably including hay, so that goats survive the rain period. Feeding areas should be well drained, and located where floodwater will not isolate any of the mobs. After the drought breaks you will probably still be drought feeding the goats in a confined or restricted area for some weeks to protect the fragile germinating pastures. Goats will chase the first green pick (Gurung et al. 1994), expending considerable energy grazing over the paddock. Goats should be kept in confined areas until new pasture is well established and can provide worthwhile grazing. At that point they can be gradually weaned off drought rations and allowed some grazing.

When the decision has been made to allow some grazing, increase grazing time each day until full grazing is provided after 6 to 7 days. Does with kids should be fed a full ration for a few weeks to ensure the maintenance of lactation. Calcium may also be limiting so limestone and salt should be fed for a few weeks (see Chapter 4, Court 2002). Allowing immediate full grazing will lead to digestive disorders.

Once goats are released onto the pasture continue to monitor them. Using the rule of thumb based on body condition scores, sheep producers are advised to stop feeding when less than a quarter of the stock remain at a score below condition of 2. There is insufficient data on which to provide a clear statement for goat producers.

Unfortunately the period when most droughts break coincides with the time when Angora goats are normally shorn in autumn and with a period of uncertainty in weather predictions.

Goats in poor condition and of light body weight are vulnerable to wet windy weather, particularly to periods of extended rainfall (McGregor 1985c, McGregor and Rizzoli 1991, McGregor 2001b). High wind speeds and unpredicted intense storms can also cause deaths in all live stock species. Short duration intense storms have caused death in goats from exposure and suffocation resulting from crushing. Even if shelter is provided goats can be caught in open paddocks by unexpected intense storms (McGregor and Rizzoli 1991, McGregor 2001b). In previous droughts, many properties have experienced their heaviest sheep losses during the period immediately following drought-breaking rain (Court 2002). Thus goat producers should be prepared to feed goats after the drought breaks and take particular notice of weather conditions and the issuing of Grazier Weather Alerts from the Bureau of Meteorology.
4. Nutrient requirements of drought fed goats

4.1 Introduction

4.1.1 Drought feeding objectives
The objectives of feeding goats during droughts are:
• to maintain the live weight of goats;
• to meet the requirements of late pregnant and milking does;
• to maintain the welfare of goats;
• to allow kids to grow to a target weight without suffering permanent setbacks.

You may also select other targets such as finishing goats for quick sale. Feed levels can then be adjusted for these aims.

4.1.2 Selecting drought feeds
Selecting the types and amounts of feeds to give goats during a drought involves six steps:
1. Determining total energy and protein requirements of each class of goat;
2. Determining the energy and protein content of available and suitable feeds;
3. Calculating which of the available and suitable fodders is cheapest;
4. Calculating the amount and cost of the selected feed;
5. Assessing the proportion of feed requirements that can be met from pasture and/or crop residues;
6. Monitoring the individual mobs and adjusting their ration up or down.

This chapter is concerned with step 1. Steps 3 to 4 are discussed in Chapter 5. There are various ways of reaching the same end point in calculating the preferred drought ration. Examples of approaches are provided elsewhere for sheep and other livestock (Court 2002, Scarlett 2000).

4.2 Energy requirements of drought fed goats
Energy is a major nutrient requirement and normally the first limitation during a drought. The energy derived from digested feed to maintain body functions and to produce fibre, foetal growth, milk or more body weight is termed "metabolisable energy" (ME). The energy value of feeds and the energy requirements are described in units of ME.

4.2.1 Maintenance energy requirements

4.2.1.1 Feeding standards
The National Research Council of the United States of America published a review of the nutrient requirements of goats and included recommendations for the provision of energy and protein (NRC, 1981a). This publication has been the basis for goat nutritional advice over the past two decades. Unfortunately the NRC review included few experimental data derived from fibre producing goats.

In Australia, the Standing Committee on Agriculture published the Feeding Standards for Australian Livestock – Ruminants (SCA 1990). This work is based in the ME system of feeding and is the basic textbook for Ruminant Nutrition in Australia. The present review is to be read in conjunction with the Feeding Standards for Australian Livestock, Ruminants. SCA (1990) includes only a small number of references to goats and concluded that the maintenance metabolism of goats was similar to that of sheep (page 23). This review provides a new analysis based on new data including Australian research not available to the NRC or SCA.

4.2.1.2 Review of maintenance requirements for goats
The NRC review derived energy requirements for maintenance from the pooled means of experimental data from 10 published sources. The NRC mean value for maintenance was 424 kJ ME/ kg0.75. The review by Ademosun et al. (1992) added two records. Ademoson et al. (1992) converted the data from Zemmelink et al. (1991) using 15.8 kJ/g digestible organic matter (DOM) (NRC 1981a) but in the present review the SCA (1990) conversion of 17.5 kJ/g DOM has been used. The mean of these 12 values is 419 kJ ME/ kg0.75 (range 365 – 482 kJ ME/ kg0.75).
During the past 20 years, data has been derived for the maintenance requirements of Australian Angora, cashmere goats and feral managed under a range of environments, experimental conditions (Table 4.1) and fed either forage only or grain/forage diets. In addition, Holmes and Moore (1981) reported the maintenance energy metabolism for feral goats as 391 kJ ME/kg^{0.75} following calorimetric studies in New Zealand. The mean value for the maintenance of live weight of Australian goats was 377 kJ ME/kg^{0.75} (range 267 – 485 kJ ME/kg^{0.75}). The mean value rises to 383 kJ ME/kg^{0.75} if the value for energy maintenance (McGregor 1988) is used rather than the value for live weight maintenance. The variation in values can be attributed to the type and size of goat used, the environment, the experimental set-up, the period of measurement and the accuracy of determination of changes in body composition.

Assuming that all reports are relevant to Australian conditions, the mean of these 21 estimates for the maintenance requirements is 404 kJ ME/kg^{0.75}. This value has been used to provide estimates of the energy requirements for the drought feeding of goats under conditions of minimal activity (Table 4.2).

Estimates of the maintenance energy requirement of goats in thermo-neutral conditions were first provided by Armstrong, D.G. and Blaxter, K.L. (1965) as 0.312 kJ ME/kg^{0.75} per day. The one estimate for Australian goats in thermo-neutral conditions (Dunshea 1987, Table 4.1) is similar to that of Armstrong and Blaxter. In practice Australian goats are not kept in thermo-neutral conditions and so these values have not been included in the calculation of energy requirements.

4.2.1.3 Maintenance energy requirements for goats during drought
SCA (1990) reports that the maintenance energy requirements for drought fed sheep and cattle may be at least 10% less than determined using various feeding systems. Whether this observation applies to goats is not known, although data in Table 4.1 and unpublished data may provide evidence for this observation in goats. The observations referred to by the SCA may in part be a consequence of experimental conditions where animals were individually fed in pens or stalls. In practice during a drought, animals will have some activity that is likely to equal or exceed the 10% of maintenance value referred to by the SCA. The energy requirement for activity is discussed further in Section 4.2.3.5. It is concluded that no deduction be made based on the above observations of drought fed sheep and cattle.

4.2.2 Energy requirements for growth
4.2.2.1 Review of energy requirements for growth
The NRC (1981a) review derived energy requirements for growth from the pooled means of experimental data from 3 published sources. The NRC mean value for growth was 30.3 kJ ME/g of growth. The review by Ademosun et al. (1992) added two records. Ademoson et al. (1992) converted the data from Zemmelink et al. (1991) using 15.8 kJ/g DOM (NRC 1981) but in the present review the SCA (1990) conversion of 17.5 kJ/g DOM has been used. The mean of these 5 values is 34.2 kJ ME/g of growth (range 22 – 42 kJ ME/g of growth).

During the past 20 years data have been derived for the growth requirements of Australian Angora, cashmere goats and feral managed in four experiments (Table 4.1). The mean value for the energy requirements for growth of these Australian goats was 39.8 kJ ME/g of growth (range 24 - 54 kJ ME/g of growth). Further calculations are possible using the data from McGregor (1988, 1995).

Assuming that all reports are relevant to Australian conditions, the mean of these 9 estimates for the energy requirements for growth is 36.7 kJ ME/g of growth. This value has been used to revise the estimates of the energy requirements for growth provided by the NRC (1981), see Table 4.2. For maximum growth of kids it is suggested that the ration contain at least 10 MJ ME/kg.
Table 4.1. Some estimates of the energy requirements for maintenance and growth of Australian Angora, cashmere dairy and feral goats

<table>
<thead>
<tr>
<th>Goat breed or strain</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Weight (Kg)</th>
<th>Season</th>
<th>Fleece at start</th>
<th>Housing and length of study</th>
<th>Ration composition</th>
<th>Maintenance (kJ ME/kg^0.75)</th>
<th>Growth (kJ ME/g)</th>
<th>Pregnancy</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Angora</td>
<td>2</td>
<td>CM</td>
<td>29</td>
<td>Spring</td>
<td>Shorn at start</td>
<td>Indoors, 12 weeks</td>
<td>Oaten chaff and 150 g/d barley</td>
<td>267</td>
<td></td>
<td>McGregor and Hodge, 1989</td>
<td></td>
</tr>
<tr>
<td>Australian Angora</td>
<td>1-2</td>
<td>CM</td>
<td>11-35</td>
<td>Spring</td>
<td>3 weeks fleece</td>
<td>Indoors, 26 weeks</td>
<td>Pellets 63% barley, 25% luceme meal, 10% lupins, 2% minerals</td>
<td>391</td>
<td>34.6</td>
<td>McGregor, 1982</td>
<td></td>
</tr>
<tr>
<td>Australian Angora</td>
<td>2 - 6</td>
<td>F</td>
<td>35</td>
<td>Winter</td>
<td>4 months fleece</td>
<td>10 weeks pregnant. Outdoor pens, 6 weeks Indoors, 7 months</td>
<td>Pellets 73% luceme, 25% barley, 2% minerals</td>
<td>390</td>
<td></td>
<td>McGregor, 1995</td>
<td></td>
</tr>
<tr>
<td>Australian angora</td>
<td>2</td>
<td>CM</td>
<td>28</td>
<td>Summer - Winter</td>
<td>Shorn at start</td>
<td>Indoors, 10 weeks</td>
<td>Persian clover (Trifolium resupinatum)</td>
<td>312^A</td>
<td>267^B</td>
<td>McGregor, 1988</td>
<td></td>
</tr>
<tr>
<td>Australian cashmere</td>
<td>2.5</td>
<td>CM</td>
<td>33-40</td>
<td>Spring</td>
<td>3 months fleece</td>
<td>Indoors, last 14 days study</td>
<td>Base diet 75% barley, 25% lupin pellets with six levels of hay, 0 to 27% Senescent summer pasture with 5 levels of barley and lupin grain</td>
<td>385^C</td>
<td>45.4^C</td>
<td>Derived from McGregor 1994</td>
<td></td>
</tr>
<tr>
<td>Australian cashmere</td>
<td>5.5</td>
<td>CM</td>
<td>37-50</td>
<td>Summer Autumn</td>
<td>6 months</td>
<td>Indoors, last 7 weeks study Indoors, last 7 weeks of 9 week study</td>
<td>485^C</td>
<td>45.4^C</td>
<td>Derived from McGregor and Umar 2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australian feral</td>
<td>0.5</td>
<td>M, F</td>
<td>14-17</td>
<td>Summer Brisbane</td>
<td>Not shorn</td>
<td>Indoors</td>
<td>Concentrate diet</td>
<td>376</td>
<td>24.8</td>
<td>Ash and Norton, 1987</td>
<td></td>
</tr>
<tr>
<td>Australian feral</td>
<td>0.5</td>
<td>M</td>
<td>14-28</td>
<td></td>
<td>Not shorn</td>
<td>Indoors</td>
<td>Concentrate diet</td>
<td>455^C</td>
<td>54.4^C</td>
<td>Derived from Norton 1982</td>
<td></td>
</tr>
<tr>
<td>Australian dairy</td>
<td>4-6</td>
<td>F</td>
<td>38-62</td>
<td>Thermo-neutral</td>
<td>Not shorn</td>
<td>Indoors, last 9 weeks of 13 week study</td>
<td>50% lucerne chaff, 50% oat grain</td>
<td>310</td>
<td></td>
<td>Dunshea 1987</td>
<td></td>
</tr>
</tbody>
</table>

^A Maintenance of body energy based on stable body condition scores

^B Maintenance of live weight

Table 4.2 Guide to the daily nutrient requirements for maintenance of goats during a drought under stable dry conditions with minimal activity. If some grazing is provided then requirements increase by 25%. Under cold, wet and windy conditions energy provision should be doubled. Data are based on the review of maintenance energy requirements of goats (see Text) and NRC (1981a).

<table>
<thead>
<tr>
<th>Live weight kg</th>
<th>Energy requirement MJ ME&lt;sup&gt;A&lt;/sup&gt;</th>
<th>Total crude protein g</th>
<th>Calcium g</th>
<th>Phosphorus g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maintenance during drought feeding in intensive feedlot type management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2.27</td>
<td>33</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>20</td>
<td>3.82</td>
<td>55</td>
<td>2</td>
<td>1.4</td>
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<td>30</td>
<td>5.18</td>
<td>74</td>
<td>3</td>
<td>2.1</td>
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<td>40</td>
<td>6.43</td>
<td>93</td>
<td>4</td>
<td>2.8</td>
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<td>50</td>
<td>7.60</td>
<td>110</td>
<td>4</td>
<td>2.8</td>
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<td>60</td>
<td>8.71</td>
<td>126</td>
<td>5</td>
<td>3.5</td>
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<td>70</td>
<td>9.78</td>
<td>141</td>
<td>6</td>
<td>4.2</td>
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<td>80</td>
<td>10.81</td>
<td>156</td>
<td>6</td>
<td>4.2</td>
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<td>90</td>
<td>11.80</td>
<td>170</td>
<td>7</td>
<td>4.9</td>
</tr>
<tr>
<td>100</td>
<td>12.78</td>
<td>184</td>
<td>7</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>Requirement for does in last 8 weeks of pregnancy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>11.12</td>
<td>156</td>
<td>5</td>
<td>3.5</td>
</tr>
<tr>
<td>40</td>
<td>12.37</td>
<td>175</td>
<td>6</td>
<td>4.2</td>
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<td>50</td>
<td>13.54</td>
<td>192</td>
<td>6</td>
<td>4.2</td>
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<tr>
<td>60</td>
<td>14.65</td>
<td>208</td>
<td>7</td>
<td>4.9</td>
</tr>
<tr>
<td>70</td>
<td>15.72</td>
<td>223</td>
<td>8</td>
<td>5.6</td>
</tr>
<tr>
<td>80</td>
<td>16.75</td>
<td>238</td>
<td>8</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>Additional requirement above maintenance for milk production during lactation. For a 12 week lactation averaging 1.5 kg milk at 9.5% fat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9.0</td>
<td>180</td>
<td>7.5</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td>Additional requirement above maintenance for growth at 50 g/day</td>
<td>1.84&lt;sup&gt;B&lt;/sup&gt;</td>
<td>14&lt;sup&gt;B&lt;/sup&gt;</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Additional requirement above maintenance for growth at 100 g/day</td>
<td>3.67&lt;sup&gt;B&lt;/sup&gt;</td>
<td>28&lt;sup&gt;B&lt;/sup&gt;</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Additional requirement above maintenance for growth at 150 g/day</td>
<td>5.51&lt;sup&gt;B&lt;/sup&gt;</td>
<td>42&lt;sup&gt;B&lt;/sup&gt;</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Additional requirement above maintenance for growth at 200 g/day</td>
<td>7.34&lt;sup&gt;B&lt;/sup&gt;</td>
<td>56&lt;sup&gt;B&lt;/sup&gt;</td>
<td>2</td>
</tr>
</tbody>
</table>

<sup>A</sup> Mega joules of metabolisable energy
<sup>B</sup> For maximum performance of kids it is suggested that the ration contain at least 10 MJ ME/kg and 16% crude protein.

Note: These macro nutrient guidelines are suggested guidelines and should be used as a starting point. The guidelines need to be modified based on regular monitoring of the live weight and body condition score of goats. During feeding in severe weather the energy requirement may be two or more times those listed.
4.2.3 Energy requirements during pregnancy and lactation

4.2.3.1 Provision of metabolisable energy

The NRC (1981a) indicate that up until day 85 of pregnancy that does be fed at maintenance and that for the last 8 weeks of pregnancy that energy provision be increased by 5.94 MJ ME/day. NRC has included in these values an allowance of 20% for does carrying twin pregnancies. SCA (1990) suggest that based on evidence for sheep and assuming a birth weight of 4 kg, that from day 66 of pregnancy energy provision be increased by initially 0.4 MJ ME/day rising gradually to an allowance of an extra 5.3 MJ ME/day. They suggest a pro rata adjustment for energy requirement based on different total birth weights. For example, twin goats with a total birth weight of 5 kg would need a 25% greater allowance. It is unclear what triplet goats weighing a total of 4 kg would require. The practical application of these recommendations is considered to be too complex during drought feeding operations on farms and Section 4.2.3.2 suggests a different approach.

Experimental evidence with Australian goats indicates that feeding below maintenance (from 0.8 to 0.5 of maintenance) from day 50 to day 85 of pregnancy will substantially increase the risk of reproductive failure whereas feeding at maintenance will provide no penalty in terms of kid birth weight (McGregor 1995).

The NRC (1981a) and SCA (1990) provide data to estimate the energy requirement for lactating goats. The SCA (1990) recommendations for sheep were used as the basis for the energy provision from day 85 of pregnancy during a large experiment conducted with pregnant and lactating Australian Angora goats (McGregor 1995). These goats were housed in small outside pens where the activity was minimal and so provide a good model for the energy requirements of typical drought fed does. The milk production and quality of these goats was determined. For an average 12 week lactation producing an average of 1.5 kg of milk with 9.5% fat, the actual energy intake over maintenance was 9.0 MJ ME/d (McGregor 1995). This value has been provided in Table 4.2 along with other nutrients as suggested by NRC (1981a).

4.2.3.2 Feeding reproducing does using maintenance requirements as the benchmark

The risks of adopting the SCA (1990) recommendation for sheep of using set allowances for pregnancy in goats assumes that the reproductive performance is similar and that farmers know the pregnancy status of their does. Often farmers do not accurately know the date of conception or the number of foetuses being carried. The practical consequence of being one oestrus cycle in error is that feeding provisions during drought could be up to 17 days in error. During mid to late pregnancy a delay of 17 days in increasing energy provision may lead to wide spread abortion in goats at about 100 day of pregnancy.

For practical farmers with larger group feeding situations during a drought it is easier to determine the maintenance requirement for does during mid pregnancy and then use adjustment factors to increase the provision of energy at the appropriate stage of pregnancy. The suggested guideline for feeding pregnant and lactating does is given in Figure 4.1 (modified from McGregor 1995). The assumptions underlying the data are:

1. The mean live weight of a flock of does during a drought will be 35 ± 0.5 kg.
2. During a drought, does in the early stages of pregnancy should be fed at maintenance.
3. Energy provision should be increased from day 66 of pregnancy (SCA 1990) in progressive steps.
4. It is unlikely that farmers know the pregnancy status of their does. This data includes 20% of does with twins, similar to that seen in practice. Frequently 5 to 10% of does are dry.
5. When ration provision is increased the rate of increase is 50 g/day every second day.
6. From about day 120 of pregnancy until kidding feed provision is ad libitum.
7. During a drought, energy provision during lactation may be restricted. Thus the feeding level shown during lactation is 60% of that consumed by does fed ad libitum.

In practice, feeding from day 140 of pregnancy and during lactation could be maintained at 2.5 times maintenance.
Figure 4.1 Suggested drought energy feeding for pregnant and lactating does. The graph shows mean (± se) intake of metabolisable energy (ME) relative to maintenance ME requirements of pregnant and lactating Australian Angora does kept in outdoor pens with minimum activity (modified from McGregor 1995). The energy requirements are increased from day 66 of pregnancy in accordance with SCA (1990) recommendations. Energy provision during lactation is 60% of that consumed by does fed ad libitum and was achieved without ill-effect.

To determine the level of energy provision from Figure 4.1:
1. Determine the energy required to maintain the pregnant does in mid pregnancy;
2. At any given stage past day 66 of pregnancy, read from the vertical axis the relative ME intake required for the doe;
3. Multiply the relative intake by the energy required for maintenance feeding.

For example: a 40 kg doe would require 6.43 MJ ME per day for maintenance (Table 4.2). At day 130 of pregnancy the relative intake should be 2.0 times maintenance (Figure 4.1). Thus the energy requirements would be 2.0 x 6.43 = 12.86 MJ/day.

Fibre growth is maintained when pregnant Merino ewes (Williams and Butt, 1989) and pregnant Angora does (McGregor 1995) are fed adequate energy to maintain maternal live weight.

4.2.3.3 Feeding twins
Clearly the energy requirement for does rearing twins will be greater than that for single rearing goats. The requirements are discussed in Section 4.2.3.1. Australian cashmere/feral does have performed similarly to the Angora does described when fed diets designed for drought feeding. When fed whole oats (97.1%) treated with urea (1.4%) plus minerals (1.5%) or oats (69%) with lucerne chaff (29.5%) plus minerals (1.5%) feral does raised kids at 106 to 171 g/d (Table 4.3). The data have been derived from McGregor and Hodge (1988) and the digestibility determinations provided by Hodge et al. (1980) have been used to determine ME intake as the experiments were conducted simultaneously using the same feed stuffs. The use of oats and urea is discussed in Chapter 4.

4.2.3.4 Impact of supplementary feeding on intake of poor quality pasture
In Texas, the intake of digestible dry matter (DDM) of Angora does grazing low quality range was increased by low levels of energy supplementation but as energy supplementation increased, forage DDM intake decreased at an increasing rate (Huston 1994). Total intake of DDM reached a plateau from supplementary feeding levels of 10 g/kg^{0.75}d. Thus as supplementary feeding level increased, complementary, additive and substitutive effects on forage intake were observed.
The implications are that when grain feeding typical 35 kg does grazing low quality forage, introduce 150 g/d and then evaluate by monitoring the does, as to the need for further supplements.

Table 4.3 A comparison of the energy intake, growth and milk production of twin rearing feral goats fed oats and lucerne or oats and urea diets (adapted from McGregor and Hodge 1988).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Doe live weight, kg</th>
<th>Doe ME intake MJ/d(^{A})</th>
<th>Kid live weight gain, g/d</th>
<th>Doe live weight change birth to 4 wk, kg</th>
<th>Milk production, kg/day</th>
<th>Milk fat %</th>
</tr>
</thead>
<tbody>
<tr>
<td>OL</td>
<td>45.6</td>
<td>18.1</td>
<td>171</td>
<td>-1.3</td>
<td>3.4</td>
<td>6.3</td>
</tr>
<tr>
<td>OU</td>
<td>46.1</td>
<td>13.6</td>
<td>106</td>
<td>-2.6</td>
<td>2.2</td>
<td>6.6</td>
</tr>
</tbody>
</table>

\(^{A}\) Determined from feed intake, digestibility data (Hodge et al. 1980) and conversions SCA (1990)

4.2.3.5 Containment areas reduce energy expenditure

Containment areas are recommended during drought feeding for two main reasons: firstly to protect the environment and sustainability of soils and secondly to reduce energy expenditure by animals. The energy expenditure of grazing animals at pasture was reviewed by SCA (1990). Calorimetric studies with ruminants have established the energy costs of walking and standing as follows:

1. Walking horizontal component, 2.6 kJ/kg live weight/km;
2. Walking vertical component, 28.0 kJ/kg live weight/km;
3. Standing compared with lying, 10 kJ/kg live weight/day.

Thus for each hundred 35 kg does that are allowed to wander around a large hilly paddock, assuming 10 km per day with a vertical climb of 100 m, compared with being confined to a suitable yard or small paddock, the additional energy expenditure approximates to 100 MJ ME per day, equal to the energy content of about 8 kg of wheat. Confining does and their kids will reduce total energy expenditure.

4.2.3.6 Early weaning and rate of feed intake

Early weaning has been suggested as a strategy to reduce total energy expenditure (Anon 1958, McInnes and Briggs 1964, Oddy 1978). When Anon (1958) weaned lambs at 7 kg, mortality was 16%. McInnes and Briggs (1964) weaned Merino x Border Leicester lambs at 27 to 59 days of age (mean 46 days) and 13.1 kg live weight and compared their growth with unweaned lambs suckling ewes in yards or when grazing at pasture. When fed oat grain and chaff diets with or without protein supplementation, the lambs weaned and fed high protein diets (17.8% crude protein, CP) grew 132 g/d, as fast as lambs suckling ewes confined to yards and fed the same diet, 117 g/d. Lambs in both these treatments grew significantly faster than lambs weaned and fed a low protein diet (10.4% CP), 71 g/d, or who suckled ewes fed the low protein diet in yards, 94 g/d, or who suckled ewes that grazed mature dry pasture 91 g/d. As grazing ewes lost 6 kg and the hand fed ewes gained 0.5 to 2.2 kg during the 10 week trial, it was concluded that it is sufficient to feed the ewes and let the lambs suckle. As only one lamb died during this experiment, it appears that weaning at 13 kg live weight can be achieved.

Oddy suggests that lambs be weaned at about 10 kg. At this age, young ruminants need very careful management and highly digestible rations. It is suggested that early weaned kids should be fed ad libitum rations of about 10 MJ ME/kg DM and 16% crude protein.

Oddy (1978) suggests a maximum rate of feed dry matter intake for sheep of about 3.5% of live weight and up to 5% in rapidly growing animals. He cautioned that these values be used as a guide for groups of animals being fed good quality mixed feed. The NRC (1981a) provides a range of maintenance intake values as a % of live weight, for different feeds and live weights. These values can be worked out from information in this review. During this review, no authoritative source of data on the food intake of goats expresses as a % of live weight was found. It would be possible to calculate such values from existing published data.
Little scientific information is available about feeding early weaned kids. The performance of cashmere kids that did not grow out well and were weaned at 13 kg in the middle of summer was reported by McGregor et al. (1988). These kids were kept in bare 0.2 ha yards and fed 400 g whole grain per day of 77.5% barley, 20% sweet lupin grain and 2.5% crushed limestone in metal troughs with 10 cm trough space/goat. Grass hay (9.6 MJ ME/kg DM) was fed ad libitum in hay racks. Bucks were separated from does to avoid harassment. Following weaning and after 2 days of rain, 15% of kids had diarrhoea. Male and wether kids grew at 78 g/d and doe kids at 57 g/d. When slaughtered at 23 kg these kids provided excellent 10 kg carcasses. This supplementary feeding resulted in an increase in the number of these weaners reaching puberty and in being available for mating (Wolde-Michael et al., 1989).

Stapleton (2002), Bell (2002) and Cunningham (2002a) have reported success in weaning straight onto stubble. Cunningham reported no problems with kids weaned onto wheat stubble. Stapleton (2002), a very experienced goat farmer in NSW, favours leaving kids on their mothers for as long as possible. He argues that during a drought, the does are better converters of rough feed to protein. He suspects that during drought many kids are weaned early anyway. Many eventually grow out but there is always a tail of about 5% that never grow out. Oldfield (2002) noted that during dry seasons like the present year, once kids were weaned the does stop going backwards. She feeds her does with barley for six weeks before and after kidding. In this manner the kids are well used to grain that is required after weaning. Stapleton (2002) tries to supply lucerne to weaned kids, either as grazing or in bales. Oldfield (2002) usually provides peas. Both of these feeds have high protein contents and are usually readily eaten.

4.2.4 Energy requirements of mating bucks
Toerien et al. (1999) reported that the energy requirements of working bucks were 460 kJ ME/kg$^{0.75}$. The energy expenditure of the 57 kg bucks was associated with the number of does marked. It is concluded that the energy requirement of working bucks is 15% greater than the maintenance requirement.

4.3 Impact of cold stress on energy requirements of goats
4.3.1 Susceptibility to cold stress
4.3.1.1 Critical conditions
The impact of cold stress on the energy requirements of grazing animals is discussed in detail in SCA (Anon 1990). The impact of cold stress on goats was recently reviewed (McGregor 2002b) and this discussion is largely taken from that review. Grazing ruminants such as goats try to maintain a near-constant body temperature of approximately 39°C, and this is not a major issue when an animal is in the “zone of thermoneutrality”. The lower limit of the zone of thermoneutrality is the lower critical temperature ($T_{lc}$). $T_{lc}$ varies with the thermal insulation and the rate of heat production of an animal. Thermal insulation is the resistance to heat loss and is provided by tissues, fleece, the boundary layer of air trapped in the fleece, and is affected by air temperature, rain fall and wind.

An animal will increase its heat production if the air temperature falls below the $T_{lc}$. The maximum attainable heat production is called the summit metabolism. In sheep, the summit metabolism is approximately 2.16 MJ/kg W$^{0.75}$ per day, where W is live weight (SCA 1990). The summit metabolism cannot be maintained for more than a few hours although a sheep can maintain half the summit metabolism for a number of days. Some examples of $T_{lc}$ are provided in Tables 4.4 and 4.5.

For a 40 kg doe, at the summit metabolism, the total energy usage in 4 hours is equivalent to 5.7 MJ, similar to the metabolisable energy content of about 500 g of wheat or barley grain.

As can be seen from Tables 4.4 and 4.5, the critical temperature in wet and windy temperature when a sheep or calf has a 10 mm coat can be as high as 27 to 32°C. The information available for goats is limited. The data for calves are provided as their coat more closely resembles that of many goats (eg feral and Boer types and Angora and Cashmere goats in the 6 weeks after shearing) although the body shape of calves is different to that of goats.
Table 4.4 Estimated lower critical temperatures (Tlc) for sheep as provided by SCA (1990) and for feral and cashmere goats (Holmes and Moore 1981, Holmes and Clark 1989)

<table>
<thead>
<tr>
<th>Animal</th>
<th>Air and feeding conditions</th>
<th>Coat depth</th>
<th>Tlc, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep, Adult</td>
<td>Still air, fasted</td>
<td>Shorn, 5 mm</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Still air, maintenance</td>
<td>Shorn, 5 mm</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Still air, full fed</td>
<td>Shorn, 5 mm</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Still air, maintenance</td>
<td>50 mm</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Still air, maintenance</td>
<td>100 mm</td>
<td>-3</td>
</tr>
<tr>
<td>Feral goat, 21 kg</td>
<td>Still air, maintenance</td>
<td>57 mm</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Wind 7 km/h, maintenance</td>
<td>57 mm</td>
<td>12</td>
</tr>
<tr>
<td>Cashmere goat, 18 kg</td>
<td>Still air, 1.25 times maintenance</td>
<td>4 mm</td>
<td>16-22</td>
</tr>
<tr>
<td></td>
<td>Still air, 1.25 times maintenance</td>
<td>8 mm</td>
<td>11-15</td>
</tr>
</tbody>
</table>

Table 4.5. The lower critical temperatures (°C) at thermoneutral conditions for a 50 kg live weight adult sheep and a 40 kg live weight calf fed at maintenance (SCA 1990)

<table>
<thead>
<tr>
<th>Coat depth</th>
<th>Wind km/h</th>
<th>Calm</th>
<th>10</th>
<th>20</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rain mm/d</td>
<td>0</td>
<td>10</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>-5</td>
<td>-2</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Calf 40 kg</td>
<td></td>
<td>22</td>
<td>25</td>
<td>26</td>
<td>28</td>
</tr>
</tbody>
</table>

Holmes and Clark (1989) reported that the Tlc of cashmere goats, weighing 14 to 22 kg, was increased by 3 to 5°C when wind speed was increased from 0.7 to 6 km/h. At 16°C, following 4 hours of simulated rain, the metabolic rate of the cashmere goats increased 90% over that of the goats in dry conditions.

4.3.1.2 Saturation of fleeces and hypothermia
Relative to sheep, goats appear to be more vulnerable to continuous rain at low wind speed and to intense storms (Wentzel et al. 1979, Holmes and Moore 1981, Poolman 1984, McGregor and Presidente 1985, McGregor and Rizzoli 1991). Part of the increased vulnerability of goats is that less rain is required to saturate their fleece compared to sheep (>7 mm of rain is required to saturate sheep). Rainwater displaces the warm insulating layer of air within the fleece. The reasons for this are discussed elsewhere (McGregor 2002b).

Holmes and Moore (1981) demonstrated that goats have a higher critical temperature than sheep when their coats were the same depth. In Holmes and Moore’s study, for sheep to have the same critical temperature as goats with a 60 mm deep fleece, the wool fleece needed to be only 30 mm deep. Signs of physiological stress increase and heat production of goats increases rapidly as the air temperature falls below 15°C and under wet and windy conditions the heat production can increase at 27 to 29°C (Wentzel et al. 1979, Poolman 1984).

Research in South Africa concluded that Angora goat deaths could occur as soon as minimum temperatures dropped below 10°C with 15 mm rainfall and a simultaneous wind run of 7.5 km per hour. These criteria had a 73% correlation to goat death rates (Rowswell 1986). In southern Australia, McGregor (1985c) found high stocking rate, low body condition score and low live weight all positively correlated to deaths of Angora goats from hypothermia.
Following shearing the general industry advice to fibre producers is that the most susceptible time for death is for:

- sheep, the first 2 weeks;
- fibre goats, the first 6 weeks.

### 4.3.1.3 Shearing practice

Shearing removes the external natural insulation of the goats and leaves them exposed to the elements. Shearing practice also reduces the total amount of insulation found on Angora goats compared to Merino sheep. Angora goats are shorn twice each year, usually in autumn and spring. As a result of shearing, the thermal insulation provided by the fleece of Angora goats during the coldest period of the year is significantly less than that of spring shorn Merino sheep. During winter for example, autumn shorn Angora goats may have 1 to 1.5 kg of fleece, whereas spring shorn Merino sheep have at least 3 to 3.5 kg of fleece (McGregor 1985b).

Birrell (1989) determined the influence of pasture and animal factors on the consumption of pasture in Corriedale sheep shorn annually and grazed on mixed perennial/annual species pastures at Hamilton, Victoria. Intake rate was elevated by 40 to 50% immediately after shearing but then took over six months (more than 180 days) in 55 kg sheep to fall to a steady state. In heavier sheep (75 kg) it took only four months (120 days) for intake rate to fall to a steady state. Farrell and Corbett (1970) provided evidence that the fasting heat production of Merino sheep increased significantly after shearing and that the return to pre-shearing values in heat production was not observed until 135 days after shearing. They concluded that sheep at pasture had an increased energy requirement for maintenance for a considerable period after shearing.

On the basis of the data provided including the observations that:

- the fleece of the Angora goat is not as efficient an insulator as is the fleece of a Merino sheep;
- Angora goats are shorn bi-annually; and
- the mean live weight of Angora goats is less than 55 kg,

it is highly likely that Angora goats suffer the effects of exposure to cold stress throughout the year.

Cashmere goats shorn twice each year will be exposed to the same risks as Angora goats. The shearing of cashmere goats in mid-winter exposes them to significant risks from weather stress. Provided adequate shelter and supplementary feeding are available, cashmere goats of low body condition score can survive snow, wet and windy conditions (McGregor 1988, 1996 and unpublished). Deaths from hypothermia will be reduced if cashmere goats are well grown by shearing time.

### 4.3.1.4 Grazer weather warnings

The methods by which sheep grazer warnings are predicted are described by the Bureau of Meteorology (Anon 1982). Warnings of wet, windy conditions are issued to enable graziers to take action to reduce losses among animals susceptible to hypothermia. The Bureau of Meteorology developed a nomogram based on research relating the physiological reaction of sheep to weather conditions. The nomogram is used as an aid in deciding whether or not an alert is warranted. Warnings are issued at a forecaster’s discretion and take into account the predictions for the lowest temperature, highest hourly mean wind speed, total rainfall, and preceding weather conditions.

Goat producers hearing sheep grazer warnings are advised to include themselves in the target audience and take appropriate action (McGregor 2001b). The South African Weather Bureau has used the criteria in Table 5.7 to determine if weather warnings are required for the Angora Goat Industry. It is suggested, in the absence of any further data, that goat farmers affected by drought conditions use these values.
Table 4.6. Cut-off values used by the South African Weather Bureau for warnings to the Angora goat industry (Poolman 1984)

<table>
<thead>
<tr>
<th>Weather condition</th>
<th>Any two of the following conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain</td>
<td>More than 5 mm of rain</td>
</tr>
<tr>
<td>Temperature</td>
<td>Less than 10°C minimum in wet conditions</td>
</tr>
<tr>
<td></td>
<td>Less than 3°C minimum in dry conditions</td>
</tr>
<tr>
<td>Wind</td>
<td>Stronger than 10 knots</td>
</tr>
</tbody>
</table>

4.3.1.5 Pattern of live weight change and susceptibility to hypothermia
Hutchinson and McRae (1969) evaluated factors associated with the survival of newly shorn sheep at Armidale, NSW. Deaths in sheep were related to a high rate of body weight loss during the 4 weeks before shearing and the actual body weight and condition score at shearing was unimportant. This advice has been repeated by Scarlett (2002). However, deaths in goats following shearing have been associated with live weight and body condition at the time of the weather event and to the stocking rate of the goats during the previous year (McGregor 1985, McGregor and Presidente1985, McGregor and Rizzoli 1991). While there is no evidence to contradict the statement “every effort should be made to stabilise live weight before shearing by feeding an increased ration”, the evidence is that goats less than 30 kg and with a body condition score of below 3 are the most vulnerable to hypothermia. It is clear that during drought, many goats will have increased susceptibility to hypothermia.

4.3.2 Implications for energy provision
4.3.2.1 Summary of impacts
The implications of the susceptibility of goats to cold stress for drought feeding are:
- feeding goats at maintenance increases susceptibility to cold stress compared with when goats are fed to grow;
- shearing increases susceptibility to cold stress for 6 weeks as a minimum;
- adult goats have higher critical temperatures compared with typical adult Australian sheep even at the same live weight;
- during drought, goat managers need to constantly monitor the Sheep Grazier Weather forecasts issued by the Bureau of Meteorology;
- when wet and windy conditions are forecast producers need to increase energy provision prior to the arrival of the weather. Given the increasing reliability of weather forecasts, it should be possible to increase energy provision 3 to 4 day prior to arrival of bad weather;
- Susceptible goats should be moved to suitable shelter;
- feeds suitable for rapid introduction need to be available.

4.3.2.2 Increased level of energy provision
In cold wet conditions the provision of energy should be increased at least twofold. Hay is the safest for such a sudden increase in the ration, but it can be gradually replaced by grain if the increase has to be sustained. Ideally begin to increase grain feeding if the onset of bad weather has been predicted. If grain alone is to be fed, then there are a number of options:
1. Increase the frequency of feeding rather than the amount offered at each feed. For example feed twice a day rather than feed a double ration once a day.
2. Feed “chocolate mealies” or slaked lime treated grain (see section 3.4)
3. Feed a non-cereal grain such as lupins, faba beans etc.

The advice for sheep producers when grain is trailed on muddy ground is to increase rations by 16% to make up for wastage caused by trampling (Holst and White 1997).
4.4 Other nutritional requirements

4.4.1 Other nutrients for drought feeding
While energy is usually the greatest requirement, other nutrients can become limited during a drought. Once an energy ration has been determined, other issues must be considered including:

- is there adequate protein in the diet?
- can goats eat enough of this ration to satisfy their needs?
- will the supplement, plus paddock feed, provide adequate roughage?
- are there enough minerals in the diet?
- are water supplies sufficient and suitable?

4.4.2 Protein requirements

4.4.2.1 Provision of crude protein
NRC (1981a) suggested daily provision of protein (see Table 4.1). Generally most hays, grains and purchased commercial pellets have adequate crude protein for adult non-lactating goats. It is common that dry grazed pasture and some browse plants and some poorer grass hays, straw and oaten grain in southern Victoria are below 7% crude protein (Hodge et al. 1980). If the crude protein fall below 7% the rate of rumen digestion will fall, as the diet is not ideal for rumen micro-organisms and appetite may drop. In response to this situation animals will catabolise (break down) their muscle protein to supply sufficient nitrogen for saliva production and rumen function but insufficient additional nitrogen for other body requirements. As a consequence, the animals will lose weight and may drop below their critical live weight. This situation is particularly dangerous for weaners and other stock below 20 kg.

For maximum performance of kids it is suggested that the ration contain 16% crude protein. Diets with more than 16% crude protein result in substantial losses of nitrogen caused by rumen degradation. Lactating does have higher requirements for protein (Table 4.1). Both kids and lactating does may need supplementation of cereal grain or hay diets with protein rich feeds such as lupins, faba beans or cottonseed meal.

Results in the USA have shown that the most strategic use of protein is to enable young female goats to reach mating live weight by 17 months of age. Feeding both energy and protein from weaning, at 5 months of age, for 3 months increased live weight 3.6 kg, mohair growth by 20% and mohair fibre diameter by <1 µm. Forage quality was low (DMD 50%) and the supplements of both energy and protein were additive to forage intake thereby increasing total dry matter intake (Huston et al., 1993).

4.4.2.2 Using urea to supply nitrogen

Most protein consumed by ruminants is denatured during rumen digestion and is either used by rumen micro-organisms for their growth or converted into urea or ammonia (Harmeyer and Martens, 1980). Urea is a chemical compound containing a high percentage of nitrogen (46%) and is a normal part of the metabolism of goats. Although it has often been referred to as a ‘protein supplement’, this is not correct, urea does not contain protein.

In drought and semi-drought conditions, urea has been used to supplement poor-quality dry pasture and low-protein hay in order to speed up the rate of digestion, increase food consumption and stop animals losing weight (Clark and Quin 1951). Such a strategy postpones the time when an energy supplement such as grain will be necessary. However if consumed in excessive amounts, urea will poison goats (McBarron and McInnes 1968). In most drought feeding situations a supplement such as molasses must be fed with urea to ensure that the supplement is effective. Urea is only effective if supplied to grazing goats while dry feed is still available or when fed with low nitrogen roughage or low nitrogen oats. Scarlett (2002) suggested that the use of urea be restricted to adult dry goats that are still in strong condition.
In the past, there has been some confusion about the safe level and method of feeding urea to ruminants. A range of experiments with sheep have shown that intakes of 20 g/day up to 100 g/day of urea can be safe when urea was fed in blocks or when sprayed onto low nitrogen herbage (McInnes and Mangelsdorf 1966, Coombe and Tribe 1963). Mortalities from urea toxicity have been reported in other studies with urea intakes as low as 8 g/day or when urea was rapidly ingested when urea was supplied by drenching or when fed as power with grain (McBarron and McInnes 1968).

Urea can be supplied in three different methods, each with its own costs and benefits. In summary:

1. Urea can be supplied in lick blocks or in drums as a liquid supplement with molasses. In drum feeders, the urea molasses mix can be toxic if too much urea is consumed in one meal, or the urea is not evenly mixed. Ideally each goat will consume 6 to 8 g of urea each day (Scarlett 2002). Norton et al. (1994) found that when feral goats were fed sorghum grain or molasses with urea as the major energy source that the goats consumed more dry matter and had higher live weight gains when the grain was fed. The digestibility of the molasses was only 56.5%, so it is not a readily digested source of energy. McInnes and Mangelsdorf (1966) found that performance of sheep fed low urea blocks (7.1% urea) was better than that of sheep fed a 30% urea block. Stapleton (2002) reported that he had no problem using 10% urea blocks with goats to make better use of standing straw. He reported that with wheat stubble, goats seem to be able to digest more of the straw than sheep. Wet stubble or stubble left in wet summers that goes grey in colour has been known to trigger Vitamin B1 deficiencies so producers need to watch for this problem when the season breaks.

2. Urea can be sprayed onto straw when it is baled. Hadjipanayiotou (1984) demonstrated that treating straw with urea and feeding it to lactating does, increased the digestibility of the straw and consequently the ME content. Spraying urea onto straw evenly spreads the urea though the roughage. Obtain further advice from an Agricultural Department on the current best practice before undertaking a urea spraying activity.

3. Urea can be sprayed onto grain. In south-eastern Australia oats are commonly used as a drought feed, but they have a low nitrogen content (7 to 9% crude protein). If these oats are fed to lactating ewes, their milk production is much lower compared to ewes that are fed oats with urea (Hodge et al., 1981). Urea sprayed on to oats has been successfully used as a drought feed for does (McGregor and Hodge, 1988). In the study of McGregor and Hodge, there was no evidence of urea toxicity even though some does consumed 29 g/d of urea (see Table 4.3).

Bogdanovic (1983) described a cost-effective method of supplementing oat grain with urea and minerals. To avoid segregation of the powdery supplements molasses was used as the binding agent. The method is to use a horizontal paddle mixer and mix the following (g/kg of air-dry grain): molasses 20 (diluted in water 2 : 1 w/w); ground limestone 14; urea 10 (diluted in water 1 : 1 w/w and added to the diluted molasses); common salt 5; potassium sulphate 4; trace mineral and vitamin premix 1. First slowly add half the molasses urea mixture, then add the mixed minerals and then add the remainder of the molasses urea mixture. Mix for 10 minutes and then store in hessian bags. The mixture can be stored for up to 12 months without separation but are best used within a few weeks.

4.4.3 Roughage

Roughage is needed by weaned kids and does in late pregnancy or in lactation. Milk production of does (Morand-Fehr 1991) and of ewes (Oddy 1978, Kenny 1985) is improved if roughage is provided in the ration. For ewes, a minimum of 30% roughage is required (Oddy 1978) and this level of roughage in practice provides good results in ewes (Hodge et al. 1980, 1981, Watson and Egan 1985) and does (McGregor and Hodge 1988, see Table 4.3).

If the main source of energy during a drought is wheat or other low fibre grains, a supplement of roughage will be necessary. Roughage may come from hay, oats, lupins pasture or crop residue. Oat grain and lupin grain provides six or more times as much fibre as wheat grain. Kenny (1985) reported that ewes fed oat grain (crude protein level 10.5%) performed better than those fed wheat. In this study the feeding of poor quality hay (crude protein 5.0%) at rates of 150 g/ewe per day in pregnancy and 350 g/ewe per day in lactation, improved the performance of ewes fed oats or wheat with or without lupins. Provision of lupins in cereal grains improved ewe performance.
The roughage may only need to be supplied in a small quantity, about 10% of the ration. It will pay to buy or retain a small proportion of hay early in the drought so that you have some roughage in autumn when pasture or crop residue is scarce. Roughage is discussed further in section 3.3.

4.4.4 Minerals and Vitamins

4.4.4.1 Minerals

The mineral requirements of goats have been reviewed by Haenlein (1992). Only two major minerals, calcium and sodium, are likely to be needed as additional supplements during a drought (SCA 1990, Court 2002). Phosphorus deficiencies may occur on some properties.

Dry pastures are likely to contain sufficient calcium. When diets consist mainly of cereal grain it is likely that calcium will become deficient. When grain is fed for more than a few weeks, calcium should be added to the ration. To prevent calcium deficiency, add 1.5% of finely ground agricultural limestone (CaCO₃ calcium carbonate) to cereal grain (that is, for every tonne of grain add 15 kg of limestone). Do not use builders lime, burnt lime or slaked lime for this purpose. The lime should be spread onto grain when filling the feed-out bin. The fine lime particles stick to the grain. Do not add lime to stored grain when filling the silo as lime may corrode the lining of the silo. If grain is being treated with urea and trace minerals use the method of Bogdanovic (1983, see section 4.4.2.1).

In Western Australia, Morecombe et al. (1990) observed that when 27 kg lambs grazing dry wheat stubble were provided with ad libitum oat grain, those provided with 2% crushed limestone grew at 83 g/d compared with the lambs fed oats without limestone who grew at 39 g/d. The sheep fed oats with limestone consumed 700 g/d of oats while the other treatment consumed 550 g/d of oats.

Sodium is deficient in most grains. Common salt (NaCl, sodium chloride) can be provided at 0.5% if needed, but often water supplies have sufficient salt to alleviate the need to supplement.

Alternatively, both salt and calcium can be provided in a salt lick. The percentage of each mineral can vary, but calcium levels above 30% start to limit uptake. You can mix your own licks cheaply or take the more expensive option of buying commercial blocks. One difficulty with licks is that some goats in the mob are shy feeders and will not eat any or enough and the intake of the others can be highly variable.

If phosphorus deficiency is identified it may be rectified by supplementation with monosodium phosphate (MSP). MSP will need to be fed out mixed with grain. For goats grazing dry grazed mature pasture, the use of a small amount of a commercial feed pellets that contain phosphorus mineral supplements may be sufficient and may be a cheaper and easier method of supplying phosphorus than using MSP. Alternatively the provision of a suitable lick block may be adequate.

4.4.4.2 Vitamins

Vitamins, 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 a good green colour, green browse plants and yellow maize. Even a short green pick will supply adequate quantities of Vitamin A. Vitamin A is stored in the liver. Young goats may experience deficiencies when they have been without green pasture, green hay or yellow maize for six months. Symptoms include night blindness, eye discharges and ill-thrift. Treat with Vitamin A or supply a feed with Vitamin A.

An inter-relationship exists between Vitamin E and selenium. Grains and hays are usually fair to good sources of Vitamin E, although considerable variation does occur. A Vitamin E deficiency induces symptoms similar to selenium deficiency (that is, still born kids and older kids that suffer from a stiff, stilted gait, lameness and ill-thrift). During droughts, wheat that has been stored for long periods can be deficient in Vitamin E. Lambs born to ewes fed wheat based diets before lambing and during lactation can become deficient in Vitamin E and die (Watson and Egan 1985, Watson et al. 1988). Watson and Egan (1985) reported the sudden deaths of 5% of lambs as a result of Vitamin E
myopathy. In wether goats fed drought rations of wheat over long periods (McGregor 1983 unpublished) the Vitamin E levels where much lower than the levels reported in ewes whose lambs had Vitamin E myopathy (Watson and Egan 1985). It would appear that precautions against Vitamin E deficiency need to be taken if wheat is to be the main energy source fed to pregnant and lactating does. Vitamin E in mineral premixes can be added to grain using the method of Bogdanovic (1983).

If you suspect these or other vitamin deficiencies, seek veterinary advice for confirmation and instructions for treatment.

4.4.5 Water consumption, quality and supply
Giger-Reverdin and Gihad (1991) reviewed the main factors affecting water metabolism and free water intake of goats. Goat are similar to other ruminants and water intake is related to: dry matter intake (water intake is about 3 times dry matter intake); composition of feeds and especially their water, salt and mineral contents; taste factors; live weight; level of milk production (water required is 1.28 kg/kg of milk); physiological status (maintenance water intake is 107 g/kg\(^{0.75}\) for a dry and non-pregnant goat, 140 g/kg\(^{0.75}\) at mid-pregnancy and 165 g/kg\(^{0.75}\) at mid-lactation); and environmental factors.

Compared with Merino sheep, goats are regarded as having a more efficient renal system (kidney function) which reduces water loss. Many authors who have studied goats, that have had access to shade, concluded that goats were better adapted to more arid conditions than sheep. However, the arid environments to which goats are “so well adapted” are characterised by low rocky ridges and scrubland plant communities. These environments allow goats to use shade during the hottest part of the day (McGregor 1986).

For many years Australian feral goats have been known to be highly dependent on drinking water (Harrington 1982). During hot dry periods more than 80% of feral goats will drink daily. Feral goats have been recorded as dying at dry water holes when water was available within 1.5 km (Harrington 1982). Henzell (1997) remarks upon the dependence of feral goats to drinking water leading them to gather at water points, where they can be trapped.

On dry annual pasture in southern Australia, particularly during drought, the moisture content of dry pasture is very low and much pasture and crop lands have been cleared leaving little shade. Thus goats are more exposed to direct sunlight and must control their body temperature by panting and sweating, particularly on hot days with strong winds. A good reliable water supply is extremely important in drought. In drought, goats will be fed diets very low in water content and therefore must be supplied with water at all times.

4.4.5.1 Water consumption
Water consumption of adult Angora goats and adult Merino sheep has been measured when grazing dry unshaded summer pastures in southern Australia (McGregor, 1986). The findings were:
- For both goats and sheep, water intakes on the hottest days (> 33°C) were double the average (when the mean temperature averaged 25°C).
- Water intake of the Angora goats was 36% greater than intake of adult Merino sheep. The intake of the goats was 1.9 compared with the intake for sheep 1.4 litres/day.
- When allowing for the differences in live weight and removing fleece weight, water intake was 50% higher in the goats, Angora goats: 55.6 ml/kg/day; Merino sheep: 36.8 ml/kg/day or Angora goats: 133 ml/kg\(^{0.75}\)/day; Merino sheep: 90 ml/kg\(^{0.75}\)/day.

Similarly, in pastoral east Africa, where the provision of shade was low, King (1983) found that the daily water intake of East African goats weighing 37 kg averaged 2.2 l/day and was higher than heavier Dorper type sheep.
Boer goats have also been recorded as having a lower water turnover rate than Merino and other southern African sheep breeds. Erasmus (1967) tested these animals at 21°C and 37°C but details of feed, housing and shade provision are not available. In this study the Boer goats drank 40% less tepid water per kg\(^{0.75}\) than sheep when under heat stress. Goat faeces were also drier, the urinary volume declined at higher temperatures and was lower than that of the sheep.

Ferreira et al. (2002) measured the water intake of castrated Boer goat kids (26 kg) and castrated Mutton Merino lambs (32 kg) receiving either a low (8.9 MJ ME/kg DM) or high (10.9 MJ ME/kg DM) energy diet when fed indoors on slatted floors. Both diets contained 12.8% crude protein. On both the high and low energy diets the Boer goats had a lower water intake per kg of feed intake and per kg of live weight gain than the sheep. Both species had a lower water intake on the high energy ration compared with that on the low energy diet. In these shaded conditions the Boer goats had a daily water intake of 171 ml/kg\(^{0.75}\) compared to the 302 ml/kg\(^{0.75}\) of the Mutton Merino. The authors conducted the study during the spring and early summer but did not report environmental temperature.

It is unclear how much the water intake of goats is reduced by the grazing and browsing of Australian scrub. Goats grazing the greener material will ingest water but may have to excrete more water if the ash content of the material is high (SCA 1990). The provision of shade in such a situation may provide more benefit in reducing water intake than the actual intake of water from the drought affected plants.

The impact of direct sunlight on the water intake of the Boer goats is not reported. It is likely that there may be differences in water consumption between Australian breeds of goat as breed differences are reported for goats in the middle east.

4.4.5.2 Heat stress and provision of shade

Following the rapid onset of hot weather, light-weight goats grazing dry summer pastures have died of heat stress. Goats grazed on unshaded pastures during summer are exposed to potentially fatal heat stress. When Angora goats (live weight 13 to 31 kg) and Merino sheep (live weight 23 to 37 kg), both with six months fleece growth, were exposed to full sun, the goats had:

- higher rectal temperatures than the sheep and
- smaller goats had higher rectal temperatures than the larger goats (McGregor, 1985a).

These findings suggest that the provision of shade during summer is more beneficial and more important for goats, particularly smaller goats, than is the provision of shade to Merino sheep.

During heat stress, rectal temperature increases and extra energy is used by the animal to remove heat. NRC (1981b) proposed that the type and intensity of panting by a heat stressed animal is used to adjust maintenance allowances. Maintenance energy allowances should be increased by 7% during rapid shallow breathing and increased by 11 to 25% for deep open-mouthed panting. Some of the increased energy requirements will be offset by a small increase in digestibility and ME value of feeds (approximately 2%) at the increased ambient temperature (SCA 1990).

Lu (1989) reviewed the impact of heat stress on goat production and concluded that goats with production demands are susceptible to heat stress as reduction in feed intake and production is common in heat-stressed goats. He also concluded that guidelines for nutritional manipulation attempting to alleviate heat stress in goats remain to be established. Balancing diets according to reduced level of production, reducing dietary forage to grain ratio, feeding fat, supplementing sodium bicarbonate and other minerals, and maximizing cold water intake may be beneficial for heat-stressed goats.
4.4.5.3 Water and feed salinity

The limited evidence available suggests that goats have similar or slightly greater tolerances to salt in water compared with sheep (see review by Church 1972). In laboratory tests the intake of water by goats and sheep falls rapidly at sodium chloride concentrations above 0.6% (Church 1972). Young sheep have difficulty thriving on water supplies with higher than 5,000 ppm salt while adult stock can handle up to 10,000 ppm, especially once they get used to it. Levels above 10,000 ppm salt need to be treated with caution (Court 2002). There are differences between the salinity limits advised for sheep (Court 2002) and those provided by Scarlett (2002) for goats (Table 4.6).

Table 4.6 Suggested maximum desirable level of salinity in water provided to stock consuming dry pasture, hay or grain

<table>
<thead>
<tr>
<th>Class of animal</th>
<th>Sheep (Court 2002)</th>
<th>Goat (Scarlett 2002)¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total salts ppm</td>
<td>EC units</td>
</tr>
<tr>
<td>Young</td>
<td>5000</td>
<td>8300</td>
</tr>
<tr>
<td>Dry adult</td>
<td>10000</td>
<td>16700</td>
</tr>
<tr>
<td>Lactating female</td>
<td>5000</td>
<td>8300</td>
</tr>
</tbody>
</table>

¹ When fed diets with salty plant material such as saltbush (*Atriplex spp*), blue bush (*Maireana spp*) or copper burr (*Scerolaena spp*) these salinity levels should be reduced by 30%

El-Gawad (1997) studied the responses of three breeds of Egyptian goats weighing 21 to 46 kg fed tap water (total soluble salts, TSS 1.05 g/litre) or saline well water (TSS 8.25 g/litre) for 6 weeks. Goats were individually housed in semi-open pens and fed on hay and a concentrate mixture. The pens provided shade. During the study the ambient air temperature ranged from 18.2 to 30.7°C and the relative humidity ranged from 35 to 81%. The chemical analysis of the tap water and the saline well water (m mol/l) were respectively: Na, 178, 1747; Ca, 48, 632; Mg, 78, 319; HCO₃, 122, 317; Cl, 313, 2660; SO₄, 411, 2573. Body weight gain was negligible and the salinity of the water did not significantly affect body weight. Feed and water intake increased in the group offered saline water. Respiration rate increased in goats drinking saline water, while rectal temperature and pulse rate were only slightly affected. Blood serum urea concentrations were elevated in goats fed saline well water. There was evidence of breed differences in the response to water salinity.

Bore water should also be tested for other toxic minerals. Saul and Flinn (1978, p 736) reported that 370 to 500 ppm magnesium had no harmful effect on young sheep. The impact of minerals in bore water on the health and productivity of goats is not known. The effect on health and production of goats of changing the drinking water from surface run off water (TSS 200 to 500 ppm) to saline bore water (TSS 5000 to 10000 ppm) as goats are grazed in different paddocks with or with out shade has not been documented.

It is likely that in grazing situations the water consumption of goats will increase as the salinity of the water increases. SCA (1990) reports that for each 1000 mg TSS/l in excess of 2000 mg/l water allowances for sheep increase by 3%. For the last two months of pregnancy and during lactation the SCA (1990) suggest that water allowances increase by 30% and that a further 1 litre be provided for each 1 kg of milk produced. Water consumption will also increase if the feed has been treated with caustic soda or slaked lime and the SCA (1990) recommend that in this circumstance an additional 2 litres per kg of treated feed (sheep) be provided. It is suggested that a similar allowance for goats be provided.

In some semi-arid areas animals are provided with saline drinking water and graze saltbush (*Atriplex spp.*) which contains up to 10% sodium chloride. Gihad and Lieth (1993) fed *Atriplex halimus* as a sole feed to camels, sheep and goats. The animals showed an increase in water intake and a decrease in feed intake compared with when clover hay was fed. Camels, sheep and goats (in descending order) were able to tolerate saltbush fodder. Gihad and Lieth (1993) concluded that other feed should be offered to livestock given *Atriplex* together with a reliable water source to maintain a balanced nutritional state.
4.4.5.4 Other water quality issues
Blue green algae can poison stock. Advice on control should be sought from Government Departments working with water supply and or environment.

Allowing goats to camp on dam walls or nearby can lead to accumulation of manure in dams following strong winds or heavy run-off. Manure washed into dams may make the water unfit for consumption. Dams contaminated with manure may have to be pumped out. During drought it may be preferable to fence out dams and reticulate water to a temporary trough.

4.4.5.5 Entrapment in muddy dams
Drying dams with deep muddy edges can cause entrapment of goats. Goats tend to have relatively longer legs than sheep and they may venture further into muddy dams than will allow an easy escape. Dams with deep muddy edges should be fenced to keep stock out, or inspected several times daily to prevent entrapment.

If goats have been stuck in dams they may need to be washed down as sticky mud can be a source of flystrike (Cunningham 2002). She noted that fly strike is not something most goat producers are used to dealing with and so they need to be prepared for fly strike if they have muddy dams.

4.4.5.6 Water supply
Budgeting for water supply must make allowance for the high levels of evaporation of water from dams and of seepage from dams. In most parts of Australia, about 1.5 to 2 m of depth is evaporated from a dam each year although this can vary with the depth and orientation of the dam. The depth of water in each dam should be measured early in the drought to assess how long supplies will last. Advice on determining the current capacity of dams and the impact of evaporation and seepage is provided by Government Departments working with water supply and or environment.

When budgeting on a water allowance you can plan for average daily consumption (4 l/head/day), however this can change dramatically with the weather. On very hot days, intake will be greatly increased so you need to be able to supply the maximum rate (up to 9 l/head/day). Court (2002) suggested an allowance of 15 metres of trough edge for 500 sheep and without further information this allowance is suggested for goats.

You may need to box some mobs later in the drought when the shallower dams dry up.

Troughs need to be checked daily and cleaned regularly.

During the present drought Cunningham (2002b) noted that evaporation had been great, primarily because of the very strong winds. As a greater amount of water is lost from a shallow dam than from a deeper dam she decided to amalgamate the remaining water from 2 adjoining paddocks by siphoning (or otherwise transferring) the water into the one dam.
5. Feed quality and quantities

5.1 Determining the energy and protein content of feeds

To determine a drought ration the energy and protein content of feeds must be known. This is particularly the case for grass hays and oats. The only way to obtain this information is to have samples tested in a laboratory (eg. FeedTest). Average feed tables are available for use as a guide. Feed values (energy and protein) can be highly variable. Variations are due to district, variety, season and growing conditions.

5.1.1 FeedTest

Before finalising plans to feed any feedstuff, by-product or unusual feedstuff to livestock, it is advisable to have a sample analysed by a feed analysis service, such as FeedTest at the Pastoral and Veterinary Institute at Hamilton, telephone 1300 655 474, fax (03) 55 730 939.

Most by-products and unusual feedstuffs should be used with caution and introduced into rations gradually, even when low prices favour their use. Factors to consider about unusual feedstuffs are: their nutritive value, palatability, possible toxicity or contamination with pesticides or heavy metals and the effects upon digestion and utilisation of the total ration. The use of by-product stockfeed needs to be declared when completing National Vendor Declaration form (Court 2002).

5.1.2 Using feed tables

Generally the most important requirement for animals in a drought is energy. The common energy supplements for goats usually provide enough protein, vitamins and minerals. The energy values of feeds differ (Table 5.1), and so does the relative cost of the energy they contain. Table 5.1 shows the energy and protein ranges commonly found in feeds in Victoria (Court 2002). Similar lists are available from each Department involved in drought assistance.

Table 5.1 Average and range in the nutritive values of common grains and forages used for drought feeds (FeedTest)

<table>
<thead>
<tr>
<th>Feed type</th>
<th>Energy MJ ME/kg as fed&lt;sup&gt;A&lt;/sup&gt;</th>
<th>Protein % Crude protein</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Common range</td>
</tr>
<tr>
<td>Wheat, Triticale, Maize</td>
<td>12</td>
<td>11.5-13.5</td>
</tr>
<tr>
<td>Barley</td>
<td>12</td>
<td>11.5-12.5</td>
</tr>
<tr>
<td>Lupins</td>
<td>12</td>
<td>11.5-12.5</td>
</tr>
<tr>
<td>Peas</td>
<td>12</td>
<td>11.5-12.5</td>
</tr>
<tr>
<td>Oats</td>
<td>10</td>
<td>5-11</td>
</tr>
<tr>
<td>Sheep pellets (brands vary)</td>
<td>10</td>
<td>9-11</td>
</tr>
<tr>
<td>Lucerne hay</td>
<td>8.5</td>
<td>7-9</td>
</tr>
<tr>
<td>Clover hay (early)</td>
<td>8.5</td>
<td>7-9.5</td>
</tr>
<tr>
<td>Pasture hay (mid-season)</td>
<td>7</td>
<td>6-7</td>
</tr>
<tr>
<td>Oaten hay</td>
<td>7</td>
<td>6-8</td>
</tr>
<tr>
<td>Grass hay (late)</td>
<td>6</td>
<td>5-7</td>
</tr>
<tr>
<td>Cereal straw</td>
<td>5</td>
<td>4-6</td>
</tr>
</tbody>
</table>

<sup>A</sup> Approximately 90% dry matter, except hay/straw 85% dry matter
5.2 Calculating feed costs

5.2.1 The cheapest source of energy

5.2.1.1 The cost per MJ of ME

In most circumstances choose the drought feed that provides energy at the lowest cost. Some goats have a special need for protein, vitamins or minerals and their ration needs to be determined separately. Table 5.2 shows the cost per MJ of ME for a range of common feedstuffs over a range of feed prices. The price of feed needs to be determined after delivery to your property.

Table 5.2 The cost of energy in different feeds over a range of feed purchase prices (as fed basis)

<table>
<thead>
<tr>
<th>Feed</th>
<th>Energy ME /kg as fed&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Cost per unit of energy at different feed costs</th>
<th>Feed purchase cost $/tonne</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MJ ME</td>
<td>cents/MJ ME</td>
<td></td>
</tr>
<tr>
<td>Wheat, Barley, Lupins, Peas</td>
<td>12</td>
<td>0.5 0.8 1.0 1.3 1.5 1.8 2.0 2.3 2.5 2.8</td>
<td></td>
</tr>
<tr>
<td>Oats&lt;sup&gt;c&lt;/sup&gt;, Sheep pellets</td>
<td>10</td>
<td>0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3.0 3.3</td>
<td></td>
</tr>
<tr>
<td>Lucerne hay, Early clover hay</td>
<td>8.5</td>
<td>0.7 1.1 1.4 1.8 2.1 2.5 2.8 3.2 3.5 3.9</td>
<td></td>
</tr>
<tr>
<td>Oaten hay, Mid-season pasture</td>
<td>7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.9 1.3 1.7 2.1 2.6 3.0 3.4 3.9 4.3 4.8</td>
<td></td>
</tr>
<tr>
<td>Late grass hay, Cereal straw</td>
<td>6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Approximately 90% dry matter, except hay/straw 85% dry matter

<sup>b</sup> When the ME content is 7 or lower, kid and adult goats will not be able to maintain their weight

<sup>c</sup> The ME content of oats can vary from 5 to 14.3 MJ/kg DM (Court 2002, Oddy et al. 1990)

5.2.1.2 Comparing the energy cost of different feeds

Table 5.2 should be used to compare the energy cost of different feeds. If barley can be delivered to your property for $270/t, you are paying an energy cost of 2.3 cents/MJ. ME. This would be the same value as buying sheep nuts at $230/t, or oaten hay at $160/t. If sheep nuts or oaten hay were selling for less than these prices, they would be better value on an energy basis.

5.2.2 Total feed costs

5.2.2.1 Proportion of a full ration to feed

The requirements for full feeding can be estimated using the information in Chapter 4. It is more difficult to estimate what proportion of this ration to feed if stock have access to pasture or stubble. It is best to start feeding with the aim of building up to one third to a half of a full ration and monitor the goats for weight gain or loss. The ration can then be altered appropriately. As a drought progresses the quantity and quality of feed in the pasture will decline and the proportion of a full energy ration that needs to be fed out will increase, up to 100% in full feedlot conditions.

5.2.2.2 The cost of a ration to be fed

To determine the cost of a ration requires four steps:

1. Determine the energy requirement in MJ per goat per day. Use Table 4.2;
2. Determine the energy cost of the ration in c/MJ/day. Use Tables 5.1 and 5.2;
3. Multiply these two values together;
4. Multiply this value by the proportion of the ration being fed. Eg. one third during the early part of the drought up to one half for most of the remainder.
Example: Determining the cost of feeding a 35 kg dry goat in a containment area/feedlot. A 35-kg wether or dry doe requires 5.8 MJ ME per day for maintenance (Table 4.2). The cost is calculated by using Table 5.2.

For barley at $270/t: Daily cost = 5.8 MJ ME/day x 2.3 c/MJ ME = 13.4 cents/day. Cost per week = 13.4 cents/day x 7 = 93.5 c/week per goats. Cost per 100 goats for each 30 day month = 100 goats x 30 days x 13.4 c/day = $402.

If one half the ration is fed out during the first month the cost would be $402 x 0.5 = $201.

For mid season hay at $240/t: Daily cost = 5.8 MJ ME/day x 3.4 c/MJ ME = 19.7 cents/day. Cost per week = 19.7 cents/day x 7 = 138 c/week per goat. Cost per 100 goats for each 30 day month = 100 goats x 30 days x 19.7 c/day = $591.

If one third the ration is fed out during the first month the cost would be $402 x 0.33 = $195.

5.2.2.3 Other costs in feeding out
The cost of feeding goats is not just the delivered feed price. Storage and handling costs, and the likely amount of wastage have to be taken into account when calculating the relative costs of feed on your farm. The weight of different feeds required to be fed out depends on the ME value of a feed (Table 5.3). If goats are provided ad libitum amounts of lower quality roughage such as barley straw, they will selectively eat the preferred parts and can waste up to 50% of the material (McGregor 1996). Holst (1997) provides further details of the relative wastage of different feeding strategies.

5.2.2.4 Keeping hay for later
Hay may be the cheapest form of energy during late spring or early summer but it may become scarce and more expensive later during autumn or even during the following season. Hay needs to be kept in case of rapid transition of feeds or if cases of acidosis occur.

5.2.2.5 Chemical residues in meat
Williamson (2002) provides some strategies for minimising the risks associated between drought feeding and potential increases in residues in meat.

5.2.3 Quantities of feed needed for maintenance of non breeding goats
Table 5.3 provides a ready-reckoner of the amount of feeds required to feed different goats at selected critical live weights. For accurate use of the table, producers need to determine the energy content of their feed.

Table 5.3 Estimated quantities of feed needed for the maintenance of 100 non breeding goats per week at selected critical live weights. Quantities are based on energy requirements in Table 4.2 for goats in stable dry conditions with minimal activity. NR: not recommended that these feeds be provided to weaned kids

<table>
<thead>
<tr>
<th>Feed type</th>
<th>Energy MJ ME/kg as fedA</th>
<th>Weaned kids 15 kg</th>
<th>Angora does 27 kg</th>
<th>Cashmere does 32 kg</th>
<th>Boer bucks 50 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat, Triticale, Maize,</td>
<td>12</td>
<td>180</td>
<td>285</td>
<td>320</td>
<td>445</td>
</tr>
<tr>
<td>Barley, Lupins, Beans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats,</td>
<td>10</td>
<td>215</td>
<td>340</td>
<td>380</td>
<td>535</td>
</tr>
<tr>
<td>Sheep pellets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lucerne hay,</td>
<td>8.5</td>
<td>250</td>
<td>400</td>
<td>450</td>
<td>625</td>
</tr>
<tr>
<td>Early clover hay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid season pasture hay,</td>
<td>7</td>
<td>NR</td>
<td>485</td>
<td>545</td>
<td>760</td>
</tr>
<tr>
<td>Oaten hay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late grass hay</td>
<td>6</td>
<td>NR</td>
<td>565</td>
<td>635</td>
<td>890</td>
</tr>
<tr>
<td>Cereal straw</td>
<td>5</td>
<td>NR</td>
<td>680</td>
<td>760</td>
<td>1065</td>
</tr>
</tbody>
</table>

A Approximately 90% dry matter, except hay/straw 85% dry matter
5.3 Weeds, native plant forage and drought feeding

5.3.1 Introduction of weed seeds

The introduction of weeds can be a problem with buying in feed, and samples should be inspected carefully for weed seeds. It is not always possible to detect a potential problem, or even to refuse a feed on these grounds. One way to minimise a potential weed problem is to restrict feeding out of any suspect fodder to a limited number of paddocks.

5.3.2 Using weeds and native vegetation as drought feed

Many pasture weed species in southern Australia have high nutritional values making the plants suitable as feed for goats (Table 5.4). In pastoral regions, many plants provide sufficient nutrients for growth and production (McLeod 1973, Wilson 1977, Table 5.4). However the long term grazing of many indigenous plants is likely to result in poor nutritional status endangering the welfare of the animals. For many plants, after the leaves have been eaten, the remaining plant stems have very low nutritive value. Some plants are not eaten when provided as the sole diet (Wilson 1977).

In many areas of Australia, the native vegetation is protected by legislation. Goat producers are advised to check first before releasing their goats into areas of native vegetation.

Wilson (1977) demonstrated that feral goats were able to digest more of the organic matter from the leaves of three tree species compared with Merino sheep. The difference in digestibility averaged 3.6% implying that the ME value of these feeds for goats was about 0.5 MJ ME/kg dry matter greater than that for sheep.

Plumb et al. (1999) reported that during drought conditions Australian feral goats consume mulga, which has a very high content of condensed tannins (5-24% dry weight). While feral goats can survive on this diet, sheep do very poorly and lose live weight rapidly. Plumb et al. (1999) have shown that the transfer of rumen contents from feral goats to sheep can significantly improve mulga digestion, suggesting that the ruminal microflora of feral goats may contain tannin tolerant or degrading bacteria. Few of the bacterial species were closely related to previously cultured bacteria, making it difficult to assign phenotypic traits. This first molecular ecological study of tannin associated microbial communities suggested that bacteria from these two groups may be either more tolerant to tannins or able to degrade tannins. One implication of this is that the ME estimates for mulga may underestimate the ME value for goats.

As plant parts die, their nutritive value will decline. For example, leaves from gum trees may have reasonable ME values when green but when dead the leaves, stems and bark ME values are low (see Table 5.4).

5.3.3 Toxic weeds

Few evaluations have been made for the presence of toxic substances or for the effects of essential oils on the digestibility of the Australian plants or upon the animals. For example, Sugar Gum can be poisonous in circumstances where the leaves have become moisture stressed and pine needles can cause problems in some circumstances. Further information can be obtained from Simmonds et al. (2000).
Table 5.4 Nutritive values for Australian plants and introduced weeds grazed by goats in southern Australia (McLeod 1973, Wilson 1977, McGregor 1992b). Values presented are averages. Nutritive value of some plants can vary significantly.

<table>
<thead>
<tr>
<th>Feed Type</th>
<th>Plant part</th>
<th>Energy MJ ME/kg DM&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Crude protein %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golddust wattle <em>Acacia acinacea</em></td>
<td>Leaves</td>
<td>7.2</td>
<td>14.7</td>
</tr>
<tr>
<td>Silver wattle <em>Acacia dealbata</em></td>
<td>Leaves</td>
<td>8.3</td>
<td>14.8</td>
</tr>
<tr>
<td>Sheoak <em>Casuarina glauca</em></td>
<td>Leaves</td>
<td>8.5</td>
<td>15.4</td>
</tr>
<tr>
<td>Bottlebrush <em>Callistemon micropunctatus</em></td>
<td>Leaves</td>
<td>6.2</td>
<td>7.0</td>
</tr>
<tr>
<td>Sugar Gum <em>Eucalyptus cladocalyx</em></td>
<td>Leaves</td>
<td>8.9</td>
<td>9.3</td>
</tr>
<tr>
<td></td>
<td>Dead leaves</td>
<td>7.4</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>Bark</td>
<td>6.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Manuka <em>Leptospermum juniperinum</em></td>
<td>Leaves</td>
<td>8.6</td>
<td>6.4</td>
</tr>
<tr>
<td>Teatree <em>Leptospermum sericatum</em></td>
<td>Leaves</td>
<td>6.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Peppercorn tree <em>Schinus molle</em></td>
<td>Leaves</td>
<td>10.2</td>
<td>20.3</td>
</tr>
<tr>
<td>Tamarisk <em>Tamarisk parviflora</em></td>
<td>Leaves</td>
<td>9.0</td>
<td>20.2</td>
</tr>
<tr>
<td>Pinetree <em>Pinus radiata</em></td>
<td>Leaves</td>
<td>7.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Saffron thistle <em>Carthamus lanatus</em></td>
<td>Leaves</td>
<td>12.1</td>
<td>14.4</td>
</tr>
<tr>
<td>Artichoke thistle <em>Cynara cardunculus</em></td>
<td>Leaves</td>
<td>11.5</td>
<td>14.8</td>
</tr>
<tr>
<td>Boxthorn <em>Lycium ferocissimum</em></td>
<td>Stems</td>
<td>9.2</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>Leaves</td>
<td>12.4</td>
<td>28.3</td>
</tr>
<tr>
<td>Horehound <em>Marrubium vulgare</em></td>
<td>Leaves</td>
<td>10.9</td>
<td>23.3</td>
</tr>
<tr>
<td>Spear thistle <em>Cirsium vulgar</em></td>
<td>Leaves</td>
<td>11.3</td>
<td>20.2</td>
</tr>
<tr>
<td>Sweat briar <em>Rosa rubiginosa</em></td>
<td>Leaves</td>
<td>10.5</td>
<td>20.7</td>
</tr>
<tr>
<td>Blackberry <em>Rubus fruticosus</em></td>
<td>Leaves and young stems</td>
<td>10.6</td>
<td>21.0</td>
</tr>
<tr>
<td></td>
<td>Old stems</td>
<td>7.4</td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>Dead stems</td>
<td>6.4</td>
<td>7.9</td>
</tr>
<tr>
<td>Belah <em>Casuarina cristata</em></td>
<td>Leaves</td>
<td>8.0</td>
<td>9.4</td>
</tr>
<tr>
<td>Kurrajong <em>Brachychiton rupestr</em></td>
<td>Leaves</td>
<td>7.0</td>
<td>15</td>
</tr>
<tr>
<td>Mimosa bush <em>Acacia farnesiana</em></td>
<td>Leaves</td>
<td>7.9</td>
<td>23</td>
</tr>
<tr>
<td>Mulga <em>Acacia aneura</em></td>
<td>Leaves</td>
<td>6.5</td>
<td>12</td>
</tr>
<tr>
<td>Tree lucerne (Tagasaste) <em>Cytisus proliferus</em></td>
<td>Leaves</td>
<td>8.0</td>
<td>13</td>
</tr>
<tr>
<td>Wilga <em>Geijera parviflora</em></td>
<td>Leaves</td>
<td>9.0</td>
<td>15</td>
</tr>
</tbody>
</table>

<sup>a</sup> DM; dry matter, that is no moisture present.
6. Goat welfare in drought

6.1 Introduction
All farmers realise that animal welfare is an important issue at all times, but especially during a drought. Activities, such as shearing or transport, may exacerbate problems associated with goats in poor condition. During drought, an outbreak of any disease or condition that reduces intake, such as high worm burdens, footrot or pregnancy toxaemia will have a greater impact than in good seasons.

The main welfare issue in assessment of drought affected animals is the subjectivity involved in deciding how much weight an animal should be allowed to lose, and consequently, when an owner should be prosecuted for cruelty (Tribe, 1985). At what point, and at what condition score, does a hungry animal, losing weight, and maintained on a sub-maintenance ration, become an animal whose welfare is at risk? Clearly, objective criteria are required. The Farm Animal Welfare Council (1994) in the UK has recommended that any sheep flock with a significant number of animals at a condition score of less than 1.5 must be regarded as demonstrating inadequate care and welfare. The application of sheep condition scores directly to goats is an area requiring further investigation.

It is unacceptable to let goats die or suffer during drought. Those goats that cannot be cared for should be humanely destroyed. As this is often a distressing task, seek advice from the Government Department managing agriculture and drought assistance and other farmers who may be undertaking the same task.

6.2. Codes of Practice
6.2.1 National Code of Practice for goats
The Primary Industries Standing Committee (PISC) supports the Primary Industries Ministerial Council of Australia and New Zealand. PISC manages several Model Codes of Practice for the Welfare of Animals. A guide for acceptable goat farming practice has been adopted at the National level (Anon 1991). This means that all parts of Australia are covered by this National Code of Practice.

Some States have also developed their own code of practice for goats. Victorians, for example should first refer to their own Code of Accepted Farming Practice for the Welfare of Goats (See Table 6.1). The Codes of Practice in Tasmania and South Australia are based on the National Code (Table 6.2).

6.2.2 New South Wales Prevention of Cruelty to Animal Act

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.’

This means that the carer of an animal must provide at least maintenance feed to prevent the animal from distress and starvation, even in drought. For further information on NSW see Clayton (2002).
6.2.3 Extracts of Code of Practice (Victoria)
Table 6.1. Code of Accepted Farming Practice for the Welfare of Goats (Victoria), (Anon 2001)

2. Drought
Drought may be defined as a severe rainfall shortage which leads to deficiency in water and/or feed supply for grazing goats. Drought is not the normal seasonal shortage of feed.

Goats being fed for survival should be inspected daily for health and vitality. Less thrifty goats may require segregation for special treatment and more frequent inspection.

Where provisions for health and vitality cannot be met, goats should be moved, agisted, sold or slaughtered humanely on site.

Drought-affected goats are highly susceptible to stress and require careful handling:
- if they are unable to rise and walk, they must be destroyed humanely on site;
- if they go down after limited exercise, they are not fit to travel, and should be fed to improve condition or, alternatively, be slaughtered humanely on site;
- if they are still able to walk but in an emaciated condition, and for which supplementary feed or agistment is not available, they should be sent directly to a knackery, rendering works or abattoir, as close as possible to their on-farm location, or slaughtered humanely on site; they should not be consigned to saleyards.

Drought-affected goats should be protected against exposure to extremes of temperature and weather.
Vehicles transporting drought-affected goats must provide adequate cooling in hot weather and protection against cold, wet conditions.

6.2.4 Extracts of Code of Practice (Tasmania)
Table 6.2. The Animal Welfare Standard for Goats published by the Tasmanian Department of Primary Industries, Water and Environment (Anon 1998)

Section 5. DROUGHT
Drought may be defined as a severe rainfall shortage which leads to deficiency in feed supply for grazing goats. Drought is not the normal seasonal shortage of feed.

Goats being fed for survival should be examined at feeding times. Less thrifty goats may require segregation for special treatment.

Where provisions for health and vitality cannot be met, goats should be moved, agisted, sold or slaughtered on site.

Drought-affected goats which are unable to rise and walk should be destroyed humanely on site. Carcasses should be burnt, buried or sent to an appropriate rendering works or knackery.

Drought-affected goats which go down after limited exercise are at their minimum survival weight. They must be fed and watered to maintain or improve condition. They are NOT fit to travel.

Drought-affected goats still able to walk but in an emaciated condition, and for which supplementary feed or agistment is not available, should be sent directly to a knackery, rendering works or abattoir, as close as possible to their on-farm location. They should not be consigned to saleyards.

Drought-affected goats should be protected against exposure to extremes of temperature and weather. Road vehicles transporting drought-affected goats and operating during cold, wet weather should have at least the front of the stock crate enclosed.
6.3 Implications of code of practice

6.3.1 Disputes
If a dispute arises regarding the welfare of goats during a drought, then reference will be made to the State Code of Practice, or if none exists, to the National Code of Practice.

6.3.2 Humane destruction of goats
Guidelines for humane destruction are provided in the Codes of Practice (Anon 1998, 2001). Information on appropriate methods of destruction can also be obtained from animal health staff from your local office of the Government Department managing agriculture.

In past droughts, Shires have made facilities available to dispose of carcases after destruction.
7. Disease and health in droughts

7.1 Most common diseases

While the focus of this review is not disease control during drought, there are a number of diseases related to nutritional management that may occur during drought management. If goats remain in good condition during a drought they will generally experience little disease. However, there are a number of diseases that are relatively common during droughts. Advice for the control of these diseases is available from your animal health adviser.

7.1.1 Grain poisoning

Grains are carbohydrate rich foods and if excessive quantities are eaten, there will be a sudden change in the microbial population in the rumen. This leads to the formation of large amounts of lactic acid that causes grain poisoning. The same effect may occur with a change in grain types.

In practice, the condition commonly occurs:

- when goats are rapidly introduced to grain;
- when there is a sudden increase in the amount of grain being fed;
- when there is a change in the type of grain or concentrate being fed or even the same grain type but from a different source.

Clinical signs vary from mild to acute depending on amount of grain and previous experience with grain. In milder cases goats have a depressed appetite and are unstable on their feet. In severe cases symptoms include swelling of the abdomen, frothing at the mouth, abdominal pain, moaning, scouring, writhing on the ground and death.

Initial management involves removing the immediate source of grain, assessing the flock and sitting up any goats that are down. Treatment is based on neutralising the excessive rumen lactic acid. Treat any affected goats with 15g sodium bicarbonate in 1 litre of water as an oral drench. Many goats once down, however, will not recover despite treatment. Valuable stock should receive veterinary attention. The flock should be given roughage such as hay until recovered. The affected animals should be removed to a recovery area.

To reduce the risk of this condition, follow guides for introducing goats to grain (Chapter 3) or feed calcium hydroxide treated grain (Chapter 3.4). When changing feeds, there should be a gradual changeover and ideally mix the new feed into the old feed over at least four feeds before the old feed cuts out. Adding 2% sodium bentonite to grain rations will help reduce the risk of poisoning during grain introduction.

Area of spilled grain can lead to over consumption of grain. It is best to clean up unintended piles of spilled grain, especially around silos. Goats will be attracted to these areas and grain poisoning will happen.

7.1.2 Pulpy kidney (enterotoxaemia)

Pulpy Kidney is an acute toxaemia caused by clostridial bacterial in the intestine. This disease is more common in goats when there are rapid changes in diets and when high-energy diets are fed. Clinical signs are sudden death with rapid rotting of the carcass.

All goats should be given two vaccinations for enterotoxaemia each year (six months apart). If in doubt about the vaccination status of the goats, give two vaccinations 4 to 6 weeks apart and then the booster six months later. On occasions, another booster may be required as the drought progress if goats are dying with the clear symptoms.
7.1.3 Worm and liver fluke infestations
Goats that are stressed for any reason may have reduced immunity and may show the effects of worm (internal parasite) infestation. Clinical signs are ill thrift, anaemia and scouring. However, if goats are scouring it may not be worms. It is important to determine the cause of the scouring before reaching for a drench gun. An effective drench early in a drought will reduce the impact of parasites on all goats.

When worms are confirmed by either WormTest or post mortem, drench the goats with an effective drench. Worm burdens should be regularly monitored through the use of faecal egg counts.

Liver fluke is more common in dry times when goats are forced to graze wet fluke-prone areas such as wet gullies and creek beds. Chronic fluke results in anaemia and ill thrift. Severely affected goats can develop bottle jaw and die suddenly. It can be confused with barbers pole worm. If in doubt consult a vet or submit faeces for a worm and fluke egg count.

7.1.4 Coccidiosis
Stress and overstocking of kids and weaners under warm, moist conditions can precipitate this disease. This disease is more common if kids are confined to feedlot or shed conditions where faecal contamination of food is more likely. The clinical effects are aggravated by concurrent worm infestations. Signs are scouring with watery faeces that may contain blood, lack of appetite, and dehydration, with anaemia and ill thrift in some cases. Consider a faecal worm test to differentiate from worms and fluke and consult a veterinarian for treatment and management advice. When lot feeding, attempt to keep the kids from walking over the feed. Ensure that the feed troughs are cleaned regularly and before feeding each day.

Stapleton (2002) reported that once it rains there is a real danger of coccidiosis in kids of up to 18 months of age, who have been fed grain on the ground. They will fade away almost overnight. He reported drenching 3 times in 3 days and moving the kids to a new paddock. It is important to keep aware of coccidiosis as it can develop very rapidly.

7.2 Less common diseases
The following are a range of less common diseases that can be encountered during a drought. The list is not exhaustive and you should contact your animal health adviser for an accurate diagnosis and remedial action.

7.2.1 Pregnancy toxaemia (Twin lamb disease)
Pregnancy toxaemia is a metabolic disorder of does that may occur in the last six weeks of pregnancy. It is caused by a lack of energy at a time when there is a high demand. The resulting rapid breakdown of body tissue to provide energy for the growing foetus also produces metabolic disorder. The does most at risk are those with inadequate nutrition, shy feeders, those in poor condition and those with multiple kids. Pregnancy toxaemia can be induced by stress or other conditions causing low intake eg worms, foot abscess and yarding.

The disease usually appears over several weeks with a few does showing signs of standing alone or lagging behind, unsteady walk and apparent blindness. Clinical signs may progress over a number of days.

Prevention involves providing an increasing supply of energy during the last 8 weeks of pregnancy. Energy requirements are discussed in Chapter 4.2.3. If pregnancy toxaemia occurs, close observation, increased energy in a good quality feed and careful management during the last weeks of pregnancy are needed. Treatment with registered products may be successful in the early stages, especially if does are still able to stand. A supply of appropriate products for emergency treatment should be kept on hand during kidding.
This disease should be differentiated from Hypocalcaemia, which is also seen in late pregnancy and early lactation but caused by metabolic calcium deficiency. The disease occurs over a short time frame and usually affects more does in the flock. These animals usually respond rapidly to treatment with calcium solution and a vet should be consulted. Prevention involves providing calcium in the diet as discussed in Chapter 4.4.

7.2.2 Plant poisoning
During drought, plants not normally considered toxic may be eaten in excessive amounts and can cause mortalities. Simmonds et al. (2000) have provided an extensive list of Australian plants and weeds that are potentially toxic to goats. Goat producers are advised to check Simmonds et al. (2000) prior to grazing weeds or areas of native vegetation. Seek veterinary advice if plant poisoning is suspected, as there is a wide range of plants that can cause problems during a drought.

7.2.3 Urea poisoning
This problem can be caused by intake of excess amounts of urea from blocks or in mixed feed. Another possibility of urea poisoning is when goats drink pools of water on the top of urea blocks after rain. Try to ensure that urea is mixed thoroughly with feed when used as a supplement (see Chapter 4). Keep urea blocks out of the rain in sheltered areas.

7.2.4 Salmonellosis
Faecal contamination of feed and water supplied with Salmonella organisms can cause a salmonella outbreak in stressed goats. It is more likely to be a problem when the area becomes wet or muddy following heavy rain or from overflowing water troughs and large mobs are feeding from the same area. Symptoms are fever, scouring and sudden death. Treatment requires antibiotics and advice should be sought from your vet. Try to reduce the risk by feeding on new trails.

7.2.5 Urinary calculi (Bladder stones)
The common predisposing cause is a limited water intake. This can occur as a result of faecal contamination of water, stagnant water or a high salt content in the water. Losses can also occur when goats are fed on grain rations without a calcium supplement. It is usually only a problem in rams and wethers. Affected goats may be dull or found after sudden death. There may be a grossly enlarged or even ruptured bladder caused by obstruction to urine outflow, or with a heavily stained belly due to urine spray. Treatment is rarely successful. The disease is best avoided by providing the goats with the highest quality water possible at all times and adding ground limestone when feeding grain.

7.2.6 Pneumonia
Pneumonia is caused by bacterial infections aggravated by dry dusty conditions. It is more common with lambs being fed on dry, dusty feeds in troughs, especially finely hammer milled hay and so may occur in kids fed under similar conditions. Symptoms are nasal discharge, coughing, ill-thrift and sudden death. To lower the risk of this disease, avoid feeding dry and dusty feeds. This may require some damping down of the feed in troughs.

7.2.7 Vitamin A and Vitamin E deficiency
Vitamin A deficiency can occur in kids born to grain fed does in drought. Grain and most hays are low in Vitamin A. Kids must be completely off green feed for some months before clinical signs will occur. For further details, see the section on Minerals and Vitamins (Chapter 4).

Vitamin E deficiency has been associated with feeding young sheep on hay or grain over extended periods, especially if the ewes have been fed on these rations during pregnancy. It may occur in goats in similar situations. Affected animals may appear bright and alert but they are reluctant to stand. In other cases there is sudden death. Examination of dead animals reveals pale muscles. Vitamin E and selenium deficiency may have an interrelationship and present with identical signs. Refer to the section on Vitamins (Chapter 4) for further details.
7.2.8 Chronic Copper Poisoning

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 can cause poisoning in droughts. The disease is brought on by some form of stress (for example, nutritional or lactation stress). Sometimes there may be copper build up in old pipes that are re-commissioned to transport water during drought.

7.2.9 Listeriosis (Circling disease)

This is caused by bacterial infection which may harbour in silage or possibly associated with close intense grazing. The condition occurs sporadically and there are two main disease patterns which don't generally occur together:

- single animals may be found circling or wandering/uncoordinated, convulsing or dead; or
- a syndrome of abortion in does and death of newborn kids.

Remove silage from goats and replace with hay whilst seeking veterinary advice for a definite diagnosis.

7.3 Potential connection between feeding and Johne’s disease

There appears to be mounting evidence that goats may contract Johne’s disease if they eat the faeces of sheep or cattle that have OJD or BJD. Cunningham (2002b) provided the following information from recent research. Details have been expanded after checking with Cunningham.

As part of pen trial research conducted by CSIRO Geelong to measure the efficiency of gamma interferon test for detecting Johne's Disease, the disease-causing bacteria was administered to goats, cattle and sheep by mouth. Researcher DJ Stewart noted that, when dosed with the JD bacteria in this fashion, goats were more susceptible to BJD than cattle and as susceptible to OJD as sheep.

The fact that this level of infection has not been found in the field infers that goats' grazing habits have a part to play in the transmission of these diseases. Demonstrating this, the owner of the sole source herd for OJD in goats in NSW has since confirmed (to Cunningham 2002) that the goats became infected after being grain fed from the same grain trail as sheep during the 1994 drought. In this situation the sheep had access to the grain trail before the goats. This is a timely reminder of the importance of drought feeding technique in disease transmission. Producers are urged to avoid faecal contamination of feed, wherever possible.
8. Discussion and implications

8.1 Outcomes of review
This review has identified and developed information for the best practice of goats during drought. Wherever possible reference has been made to original scientific data. Where relevant data is available for goats, the recommendations provided often differ to those provided for sheep. This project has enabled the first interim determination of critical live weights for goats. Where relevant data for goats is not available, the work relies on research undertaken with sheep.

The review has updated and revised the energy requirements for goats for maintenance and growth based on published and unpublished research with Australian goats. A number of useful existing and potential practices for improving the nutritional management and welfare of goats during drought have been identified. The impacts of cold and heat stress on the energy requirements of goats have been reviewed. Research on water requirements of goats has been summarised. Welfare requirements of goats during drought have been briefly reviewed.

The review has identified a number of deficiencies in knowledge regarding best practice and welfare of goats during drought. The review does not claim to be exhaustive but presents as a manual containing a substantial amount of technical information pertaining to the drought management of Australian goats. There are a number of significant gaps in our knowledge that should be rectified and in some areas the suggestions need to be validated.

8.2 Drought, grazing and critical live weights
Drought is a feature of the Australian farming landscape. The severity of seasonal and long term drought is indicated by the quantities of fodder it is necessary to feed, while the length of drought is the period between the commencement and conclusion of hand-feeding. Drought is inevitability associated with stocking rate. Increasing stocking rate increases the severity and onset of drought.

All farmers need to prepare for drought. For drought strategies to be successful, they need to be flexible. They need to be capable of being implemented and varied according to the severity and duration of the drought. Live stock producers have a range of drought strategies including:
1. feeding all the stock on the property;
2. culling and selling some stock;
3. agisting stock on another property;
4. selling all the stock.

Most goat farmers use option 2. Most goat producers aim to keep their breeding flock substantially intact so they can recover their stock numbers as rapidly as possible when the drought breaks. Option 2 reduces the costs of feeding and avoids expensive purchases of replacement stock when the drought ends.

In experiments, separately grazed sheep required significantly more supplementary feeding than separately grazed goats as the pasture grazed by the goats had significantly more herbage available at the start of the drought period. At the recommended stocking rate, goats grazed with sheep had similar requirements for supplementary feeding but when the stocking rate was 25% above the long term recommended level, the goats had twice the requirements of the sheep grazing these pastures.

In many environments in Australia, it is normal over a 12 to 16 week period in the summer, for sheep to experience a 25 to 30% loss of live weight. In some districts such a live weight loss only occurs during long term droughts. Supplementary feeding should be started well before goats reach their critical weight, when their health and welfare is endangered. The critical live weights for sheep have been defined. The critical live weights for flocks of different goat breeds have not been previously defined. This review determined that critical live weights (including fleece weight equal to half a shearing interval) for the different goat breeds should be: does, Angora 27 kg, cashmere 32 kg, Boer goats 35 kg; wethers add 20% to doe critical live weight; bucks add 40% to does critical live weight.
If the seasonal peak method is used to determine the critical live weight the value is: 30% less than the previous peak live weight plus 1 kg for each year of age plus estimated fleece weight.

Body condition scoring can be used to determine the timing of supplementary feeding. Supplementary feeding should begin when half the goats in a flock have fallen to a body condition score of low 2 (2-, lean or backward store). For grazing goats, feeding should be increased until half a maintenance ration is fed. If body condition continues to fall, the feeding rate should be increased until body condition is maintained. After a drought has broken, feeding can cease when only a quarter of the stock remains at a body condition of 2- or less.

8.3 How to manage goats in a drought

Adult goats above the critical live weight, can be allowed to lose some weight and condition at the start of a drought. In drought feeding start feeding goats when they are 3 kg above the critical live weight, and the goats can lose weight during the introductory period without drastically altering their chances of survival.

Goats have to be brought gradually onto cereal grain such as wheat, barley, triticale, maize, sorghum and commercial pellets or “sheep nuts” or any ration that is high in starch and low in fibre. The gradual introduction is required as a sudden change in diet can cause grain poisoning. Train goats that have not been fed grain before by including previously fed goats in the mob to encourage the inexperienced goats to feed. New kids can be taught to accept hand feeding before weaning by learning from their mothers to accept grain. When starting to feed inexperienced goats, use good-quality hay and spread it over a large area so it is accessible to all the goats at the same time. The cereal grain ration should be started at the rate of 50 grams per head per day for adult goats, (25 grams for weaners) and increased slowly at a rate of 50 g every second day until the required ration is reached. Oats and lupins have a higher fibre content than the other grains and full rations may be built up more quickly.

When goats are fed in groups, gorging is likely to occur, especially since a substantial proportion of animals (10 to 20%) could be shy feeders or non-eaters. Gorging will result in grain poisoning and possibly death. If many cases of grain poisoning occur, particularly at the 2-3 week stage, the program should be modified by not increasing the ration for a few days and providing roughage (hay).

In practical terms, some goats can be fed diets consisting only of wheat grain without signs of grain poisoning. When roughage may be unavailable or very expensive, it may be more cost effective to draft off the shy feeders and provide them with a ration of 30% roughage. The remaining goats may be fed less roughage. Experience has shown that when feeding full drought rations of cereal grains to goats when there is little or no roughage available it is best to feed each day. It is possible to feed goats less frequently than 7 times per week when less than a full ration of cereal grain is fed and dry standing pasture residues are available or when low energy oats or other non-cereal rations are being provided.

It is especially important to avoid sudden changes in the ration. 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 over at least a week. Feeding processed grain to goats can increase the incidence of grain poisoning and result in significantly reduced appetite.

Feed can be supplied in trails, with troughs, metal feeders, super spreader, using salt to limit intake but feed wastage can be up to 50%. There are other factors such as weather and shy feeders that are important.

Research with goats fed whole grain wheat without an introduction period showed that slaked lime treated whole grain wheat diets increased rumen pH when compared to diets without slaked lime. These results suggest that treating wheat with 2% slaked lime for rapid introduction to goats is a practical method for rapid introduction to high-energy grains. Ammonium chloride (0.5%) should be added to cereal grain to prevent formation of urinary calculi in wethers and bucks.
The management of goats during a drought depends on knowing how the animals are faring. The only real way to know how they are going is to weigh and condition score them. Goats need to be inspected regularly. Fence lines need to be checked to release any goats caught in fences.

After the drought breaks, goats should be kept in confined areas until new pasture is well established and can provide worthwhile grazing. At that point they can be gradually weaned off drought rations and allowed some grazing. Does with kids should be fed a full ration for a few weeks to ensure the maintenance of lactation. Calcium may also be limiting so ground limestone and salt should be fed for a few weeks. Once goats are released onto the pasture continue to monitor them.

Goats in poor condition and of light body weight are vulnerable to wet windy weather, particularly to periods of extended rainfall.

8.4 Feeding goats in a drought

8.4.1 Objectives and key steps

The objectives of feeding goats during droughts are:
1. to maintain the live weight of goats;
2. to meet the requirements of late pregnant and milking does;
3. to maintain the welfare of goats;
4. to allow kids to grow to a target weight without suffering permanent setbacks.

Selecting the types and amounts of feeds to give goats during a drought involves six steps:
1. Determining total energy and protein requirements of each class of goat;
2. Determining the energy and protein content of available and suitable feeds;
3. Calculating which of the available and suitable fodders is cheapest;
4. Calculating the amount and cost of the selected feed;
5. Assessing the proportion of feed requirements that can be met from pasture and/or crop residues;
6. Monitoring the individual mobs and adjusting their ration up or down.

8.4.2 Energy requirements

Energy is a major nutrient requirement and normally the first limitation during a drought. This review determined that the maintenance energy requirement of goats is 404 kJ ME/kg$^{0.75}$. The review determined that energy requirements for growth of goats is 36.7 kJ ME/g of growth. These determinations can be used to calculate the energy provision required for goats of different live weights and production.

The suggested guideline for feeding pregnant and lactating does during drought is:
1. During a drought, does in the early stages of pregnancy should be fed at maintenance.
2. Energy provision should be increased from day 66 of pregnancy in progressive steps.
3. From about day 120 of pregnancy energy provision should be *ad libitum*.

In practical terms this translates to 1.1 maintenance at day 90, 1.4 maintenance at day 110, 2.0 maintenance at day 130 and from day 140 of pregnancy and during lactation 2.5 times maintenance.

The energy requirement of working bucks is 15% greater than the maintenance requirement.

In severe drought conditions it is suggested that kids could be weaned at about 10 to 13 kg. At this age, the kids need very careful management and highly digestible rations. It is suggested that early-weaned kids should be fed *ad libitum* rations of about 10 MJ ME/kg DM and 16% crude protein. The idea of early weaning is to reduce the energy used to produce milk. This approach has not been clearly documented for goats.
8.4.3 Impacts of management and cold stress on energy requirements

Containment areas are recommended during drought feeding for two main reasons: firstly to protect the environment and the sustainability of soils and secondly to reduce energy expenditure by animals.

The impact of cold stress on the energy requirements of goats is large. Under adverse conditions the energy requirement of goats will be two or more times maintenance requirements. A goat will increase its heat production if the air temperature falls below the critical temperature. The maximum attainable heat production of a goat cannot be maintained for more than a few hours (about 4 h) before death. Relative to sheep, goats appear to be more vulnerable to continuous rain at low wind speed and to intense storms.

Goat producers hearing sheep grazier warnings are advised to include themselves in the target audience and take appropriate action. If any two of the following weather conditions arise, goat producers should take precautionary action to reduce the risks of goat deaths:
1. Rain, more than 5 mm;
2. Temperature, less than 10°C minimum in wet conditions, less than 3°C minimum in dry conditions;
3. Wind, stronger than 10 knots.

The implications of the susceptibility of goats to cold stress for drought feeding are:
- feeding goats at maintenance increases susceptibility to cold stress compared with when goats are fed to grow;
- shearing increases susceptibility to cold stress for 6 weeks as a minimum;
- adult goats have higher critical temperatures compared with typical adult Australian sheep even at the same live weight;
- during drought, goat managers need to constantly monitor the Sheep Grazier Weather forecasts issued by the Bureau of Meteorology;
- when wet and windy conditions are forecast producers need to increase energy provision prior to the arrival of the weather. Given the increasing reliability of weather forecasts, it should be possible to increase energy provision 3 to 4 day prior to arrival of bad weather;
- susceptible goats should be moved to suitable shelter;
- feeds suitable for rapid introduction need to be available.

8.4.4 Protein requirements

Generally most hays, grains and purchased commercial pellets have adequate crude protein for adult non-lactating goats. It is common that dry grazed pasture and some browse plants and some poorer grass hays, straw and oaten grain in southern Victoria are below 7% crude protein. As a consequence animals fed these feeds will lose weight and may drop below their critical live weight. This situation is particularly dangerous for weaners and other stock below 20 kg.

For maximum performance of kids it is suggested that the ration contain 16% crude protein. In drought and semi-drought conditions, urea has been used to supplement poor-quality dry pasture and low-protein hay in order to speed up the rate of digestion, increase food consumption and stop animals losing weight.

In drought and semi-drought conditions, urea can be used to supplement poor-quality dry pasture and low-protein hay and low protein grain in order to speed up the rate of digestion, increase food consumption and stop animals losing weight. Urea can be sprayed on to roughage or grain or fed in licks or with molasses. Practical experience indicates that urea supplementation can be effective as long as appropriate precautions are taken to prevent urea poisoning.
8.4.5 Other nutritional requirements

It will pay to buy or retain a small proportion of hay early in the drought so that you have some roughage in autumn when pasture or crop residue is scarce. Hay will be required during lactation, for shy feeders and if full cereal grain feeding is required.

Dry pastures are likely to contain sufficient calcium. When diets consist mainly of cereal grain it is likely that calcium will become deficient. To prevent calcium deficiency, add 2% of finely ground agricultural limestone (CaCO₃ calcium carbonate) to cereal grain.

Sodium is deficient in most grains. Common salt (NaCl, sodium chloride) can be provided at 0.5% if needed, but often water supplies have sufficient salt to alleviate the need to supplement.

Vitamins, A and E, are the only vitamins likely to be deficient as a direct result of drought feeding.

8.4.6 Water

Water intake of Angora goats grazing dry unshaded pastures was 50% greater than that of Merino sheep. There is some evidence that Boer goats consume less water than sheep.

Goat farmers should ensure that adequate water and shade is provided to all goats grazing dry summer pastures and during drought feeding, especially young and light weight goats. If goats exhibit signs of being heat stressed, maintenance energy allowances should be increased by 7% during rapid shallow breathing and increased by 11 to 25% for deep open-mouthed panting.

The limited evidence available suggests that goats have similar or slightly greater tolerances to salt in water compared with sheep. When budgeting on a water allowance you can plan for average daily consumption (4 l/head/day), however this can change dramatically with the weather. On very hot days, intake will be greatly increased so you need to be able to supply the maximum rate (up to 9 l/head/day). Allow enough trough space so that 10% can drink at any time, or 15 metres of trough edge for 500 goats.

8.5 Feeds and feed costs

The cost of a ration largely depends on the ME content and the purchase and delivery charges. The energy value of feeds can be determined by using a feed table or by testing. To determine the cost of a ration requires four steps:

1. Determine the energy requirement in MJ per goat per day;
2. Determine the energy cost of the ration in c/MJ/day;
3. Multiply these two values together;
4. Multiply this value by the proportion of the ration being fed. Eg. one third during the early part of the drought up to one half for most of the remainder.

Before finalising plans to feed any feedstuff, by-product or unusual feedstuff to livestock, it is advisable to have a sample analysed. In most circumstances choose the drought feed that provides energy at the lowest cost.

8.6 Weeds and native vegetation

The introduction of weeds can be a problem with buying in feed.

Many pasture weed species in southern Australia have high nutritional values making the plants suitable as feed for goats. However the long term grazing of many indigenous plants is likely to result in poor nutritional status endangering the welfare of the animals. For many plants, after the leaves have been eaten, the remaining plant stems have very low nutritive value.

In many areas of Australia, the native vegetation is protected by legislation. Goat producers are advised to check first before releasing their goats into areas of native vegetation.
Few evaluations have been made for the presence of toxic substances or for the effects of essential oils on the digestibility of the Australian plants or upon the animals. For example, Sugar Gum can be poisonous in circumstances where the leaves have become moisture stressed and pine needles can cause problems in some circumstances. Further information should be obtained from Simmonds et al. (2000).

8.7 Goat welfare and disease

There is a National guide for acceptable goat farming practice that describes actions relevant during drought. This means that all parts of Australia are covered by this National Code of Practice. Some States have also developed their own code of practice for goats. Producers should become familiar with these Codes. Animal welfare is an important issue at all times, but especially during a drought. Activities, such as shearing or transport, may exacerbate problems associated with goats in poor condition. The main welfare issue is assessment of drought affected animals and in deciding how much weight and body condition an animal should be allowed to lose.

There are a number of diseases that are relatively common during droughts. Producers should become familiar with the signs of these diseases and how to take preventative measure to minimise their occurrence.
9. Recommendations

On the basis of the findings of this review the following recommendations are made:

1. That the findings be published and made available to goat producers and advisory agencies

This interim technical report should be produced in pdf format and made available on the RIRDC internet site as an interim technical manual. It would be beneficial if the location of the technical report could be highlighted in some manner to enable it to be easily found. The producer bulletin should be distributed via industry networks and the DNRE internet site.

Extension articles should be written for industry journals and publications. Appropriate material should be included in the next revision of Australian Goat Notes.

2. That industry associations be encouraged to link their internet sites to the drought feeding information on the RIRDC and DNRE internet sites

RIRDC should encourage the goat industry associations, product groups and breed societies to link their internet sites to the RIRDC web page and specifically to this drought feeding report.

3. This review should be revised when the current long term drought is broken

The current review was undertaken with short lead times and on a limited budget. Feedback should be sought on this report. Generative learning from industry about their drought feeding experiences should be captured in a workshop or similar medium. The outcomes from such a forum should be analysed and appropriate findings incorporated into a revised technical manual.

4. That validation of unpublished information be undertaken

This review is the best available information for goat producers but it requires further work to validate many of the issues raised. The review uncovered critical gaps in our knowledge of the best strategies for drought management and nutrition of goats. Some important information that has been included has not been scientifically accepted by peer review. This information should be scientifically analysed and published so that its soundness and suitability for inclusion in the technical manual can be assessed.

For example, the following are areas where existing information needs to be fully analysed and published:

- The applicability of body condition scores to the assessment of welfare status of goats and to susceptibility of goats to hypothermia;
- The relationship between body condition scores, drought feeding, improvements in nutrition and changes in body reserves of drought affected goats;
- The suitability, implications and appropriate methods of feeding wheat to goats under simulated drought conditions;
- The relationship between the live weight and body condition of goats and their voluntary food intake.

5. Investigate a number of important areas impacting on drought management of goats

The review has highlighted a number of areas where information is lacking. These include: confirming the critical live weights of goats in a practical manner; documenting objective guidelines for the early weaning of kids during drought; and confirming how these guidelines apply to the new genotypes of goats being farmed under Australian conditions.
10. References


Bell, B., 2002. Personal communication.


Court, J., 2002. Drought feeding and management of sheep. (Department of Natural Resources and Environment: Melbourne).


McGregor, B.A., 2002a. Assessment skills for goat meat marketing. Agriculture Note AG0997, 3 pp. (Department of Natural Resources and Environment: Melbourne).


Appendix 1 Further information

All the State Departments involved with agriculture have drought information on their internet sites. The following links take you directly to those web pages.

Queensland Department of Primary Industries

New South Wales Department of Agriculture

South Australian Department of Primary Industries and Resources

Department of Agriculture Western Australia

Victorian Department of Primary Industries
Appendix 2 National Vendor Declaration

### Part A

<table>
<thead>
<tr>
<th>No. of salesman</th>
<th>Enum. Code</th>
<th>Goats Purchased</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Goats Purchased</td>
</tr>
</tbody>
</table>

**Vendor's Property Identification Code**

- [ ] Yes
- [ ] No
- [ ] Don't Know

**Date of Shipment**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Destination**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Place of Loading**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Dispatch Date**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Number Plate**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Breed/Type**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Sex**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Date of Shipment**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Dispatch Date**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Carrier**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Driver's Signature**

| [ ] Yes
| [ ] No
| [ ] Don't Know

**Part B**

1. **Were all the goats bred and raised on the vendor's property?**
   - [ ] Yes
   - [ ] No
   - [ ] Don't Know

2. **If NO, how long ago were the goats obtained or purchased?**
   - [ ] Less than 2 months
   - [ ] 2-6 months
   - [ ] 6-12 months
   - [ ] More than 12 months

**Part C**

- [ ] Agents' Declaration for Goats Sold
- [ ] Vendor Code
- [ ] Agent's Code
- [ ] Stock Agent Company
- [ ] No. of goats purchased
- [ ] Date
- [ ] Agent's Signature

**Part D**

- [ ] Agents' Declaration for Goats Sold
- [ ] Vendor Code
- [ ] Agent's Code
- [ ] Stock Agent Company
- [ ] No. of goats purchased
- [ ] Date
- [ ] Agent's Signature

---

**Please ensure every section is fully completed.**
This National Vendor Declaration (goats) was developed with the support of all sectors of the goat industry as a voluntary scheme to assist producers supply commercially valuable information on goats consigned for sale or slaughter.

Any false or misleading statements made in a completed declaration may lead to prosecution and/or attract civil action by the purchaser.

Why is a declaration necessary?

This declaration is a part of the voluntary scheme, developed with the assistance of all goat industry sectors, to build customer confidence in the safety of Australian goat products.

By completing this declaration form you will provide information demanded by our customers about the treatment history and residue status of goats and thereby encourage increased global goat meat usage.

For store buyers the information provided will enhance the husbandry of purchased stock and maximise the effectiveness of any subsequent veterinary treatments.

Identical Notes

Property Identification Code

The Property Identification Code (PIC) is the current property number allocated to your goat producing property by the relevant State/Territory Government authority. The PIC is commonly known as the property’s “tail tag number” because the same number appears on the tail tags used for the identification of cattle leaving the property.

Identification of goats

The identification of goats creates a clear lineage between the livestock and the information provided on this form. Ear tagging, ear notching, tattooing or distinctive nose or head raddles may be used for identification purposes.

The sheep industry is currently negotiating the introduction of a national sheep identification system. This voluntary system should also be available in the near future for goats.

Domestication Requirements (Question 2)

Animal welfare issues may arise when goats which have not been sufficiently domesticated are handled. Trapped fetal goats are not eligible for export to Saudi Arabia. Goats for live export should be kept in holding paddocks and fed and watered from troughs prior to delivery to the feedlot.

Veterinary Treatments (Question 3)

Includes veterinary drugs and chemicals administered by mouth (orally), to the coat by injection, including antibiotics, vaccines and worm, fly, lice treatments, but excluding vitamin and mineral treatments. For kids this also includes exposure to drugs or chemicals that may be excreted in the milk of lactating nannies.

Withholding Periods - WHPs (Question 3 & 4)

A withholding period (WHP) is the period following treatment when goats or kids are unsuitable for processing for domestic consumption in Australia.

- The slaughter WHP is the minimum time period that must elapse between the treatment of livestock with a veterinary treatment and the delivery of livestock for slaughter.
- The grazing WHP is the minimum time that must elapse between the treatment of pasture or crops with herbicides and/or pesticides and the grazing of those pastures or crops by livestock.

WHPs are set to ensure that residue resulting from the treatment fall to levels below the Australian maximum residue limits.

Feeding Restrictions (Question 5)

State and Territory laws prohibit the feeding of meat and bone meal to goats, cattle, sheep and other ruminant species. Contact your State and Territory Agriculture/Primary Industry Department for more details on these feeding restrictions.

Some overseas customers also require that the goats receive no feed animal material such as meat and bone meal as well as animal fat such as tallow which may be included in supplementary feed materials.

Additional Information (Question 6)

Use this section to provide other information on chemical use, animal health status or commercial matters that are not covered specifically on the form. Additional PICs may also be recorded in this section.

Scabbery Mouth Vaccination

Scabbery Mouth is a viral disease of sheep, lambs, and goats causing a short-term effect to livestock which generally recover fully in approximately three weeks. Life-long immunity to the virus is generally achieved post-vaccination.

To meet the requirements of some live sheep, lamb, and goat markets, immunity to the virus is required. Consult your local agent, exporter or State Department of agriculture for specific market requirements.

Kid

Is defined as female, castrate or entire male caprine that has no evidence of permanent incisor teeth.

Muzzling Dogs

Dog bites cause carcass damage. When handling goats prior to slaughter all dogs should be muzzled.

Hormone Treatments

It is illegal to administer hormone treatments to goats in Australia for growth promoter purposes.

Export Slaughter Intervals (ESIs) for Goat Parasiticides - July 2002

The export slaughter interval is the minimum suggested time interval that should elapse between the last treatment of an animal, including consumption of treated feed, and slaughter for export.

The withholding period is the minimum period that must elapse between the last treatment of an animal, including consumption of treated feed, and slaughter for human consumption in Australia. The WHP is a statutory requirement. ESIs and WHPs shown in the following table are in days, unless otherwise indicated.

<table>
<thead>
<tr>
<th>Agvet CHEMICAL PRODUCT</th>
<th>WHP (days)</th>
<th>ESI (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alben</td>
<td>10</td>
<td>NA</td>
</tr>
<tr>
<td>Amitik EC &amp; WP</td>
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<td>NA</td>
</tr>
<tr>
<td>Barcarded S</td>
<td>8</td>
<td>NA</td>
</tr>
<tr>
<td>Blockade S</td>
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</tr>
<tr>
<td>Cloud S</td>
<td>3</td>
<td>NA</td>
</tr>
<tr>
<td>Di-Jet</td>
<td>14</td>
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</tr>
<tr>
<td>Di-Trole</td>
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<td>NA</td>
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<tr>
<td>Fastax</td>
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<td>NA</td>
</tr>
<tr>
<td>Fenbendazole (4 Farmers)</td>
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</tr>
<tr>
<td>Fenbendazole (WSD)</td>
<td>14</td>
<td>NA</td>
</tr>
<tr>
<td>Flukare S</td>
<td>28</td>
<td>NA</td>
</tr>
<tr>
<td>Fly Strike Powder (Coopers)</td>
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<tr>
<td>Fly Strike Powder (WSD)</td>
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</tr>
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<td>Mulsing Powder</td>
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</tr>
<tr>
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<td>Nucidol 200</td>
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<td>Parafend</td>
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<td>Valbavets 5/LG Drench</td>
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</tr>
<tr>
<td>WSD Albendazole</td>
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</tr>
</tbody>
</table>

Notes:

The above list includes those products where goats appear on the label and dose/application rates for goats are provided. There are no ESIs currently available for use of these products. Data for the establishment of export slaughter intervals will be progressively sought but may not be available.

It is recognised that many products available for sheep and cattle are used off label for goats. Products without goats on this label should not be used on goats for export meat production unless there is a permit for the use issued by the National Registration Authority.

IMPORTANT INFORMATION

- The label WHP is the minimum legal requirement at all times.
- Label directions for use must be strictly adhered to for the ESI to apply.
- "NA" indicates that an ESI is yet to be determined.

Updated ESI information is available on the internet at the MLA website www.mla.com.au/esi or from the MLA Infoline on 1800 635 445.