Farming Meat Goats

Breeding, Production and Marketing

Barbara Vincent

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This book is dedicated with love to my husband Claude,
who personifies the Australian pioneering spirit.

'When the going gets tough, the tough get going'

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Preface

When we moved to our property many years ago the previous owner asked if we would mind keeping his daughters' pet goat, and a few others to keep him company. We agreed, and inherited 'The Pet' (the biggest Saanen/Anglo Nubian × wether I've ever seen), 'The Company' (47 does) and an enormous black cashmere buck that, we assumed, they must have forgotten to mention. So began a love affair with one of the most engaging, intelligent, mischievous and exasperating species of animals that we have ever had the fortune – and misfortune – to know. We have made some errors in the husbandry and breeding of our goats, which were not very good for the bank account or the goats, especially not the dead ones! We hope that the information in this book will help other breeders to avoid some of our mistakes and perhaps benefit from some of the things that we have learnt over the years.

Barb Vincent
September 2004

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Introduction

Goats belong to the Bovidae family in the order of even-hoofed animals called Artiodactyla. Goats and sheep make up the tribe Caprini within the order of Bovidae. They evolved 20 million years ago in the Miocene Age and are herbivorous placental mammals. One of the smallest domesticated ruminants, the goat has been used for meat, fleece, milk and hides for thousands of years and was domesticated long before many other types of livestock.

Seventeenth-century mariners are believed to have introduced goats to islands off the Australian mainland as a source of food. Later, settlers, miners and road and rail construction gangs brought goats to the mainland where, due to escape or abandonment, a large feral population of goats became established during the next 200 years.

The population and distribution of feral goats is affected by several factors – predation, terrain, water and feed. Goats' main predators are dingoes, wedge-tailed eagles, goannas, feral pigs, foxes, feral dogs and, last but not least, people. Feral goats occur in four main types of terrain in Australia:

- acacia scrublands (mulga) of Queensland, New South Wales, Western Australia and South Australia;
- high-rainfall zones of southern and eastern Australia;
- sheep and wheat belts of southern and eastern Australia;
- 'hilly terrain in the arid zone which has some scrub and sparse herb layer' (Johnson 1994).

The population of feral goats also depends on the quantity and location of water in relation to available feed. For feed, goats can survive in areas where many other ruminants would starve, because they are primarily a browsing animal. They do well on what would be very poor feed for cattle and sheep. For this reason they are often used for weed control, especially of blackberry and wattle. In fact, the major populations of feral goats are found in

the Acacia shrub lands (mulga country) of Queensland, New South Wales, South Australia and Western Australia.

Australia is developing a domestic goat meat industry, driven by expanding domestic and export markets during the past 25 years or so. Goat meat has become a valuable export industry that can no longer be sustained by harvesting the rapidly depleting feral goat population. This industry has given birth to a farm-based goat meat breeding program that has grown fast since the early 1990s. The pace of growth has been even more rapid since the introduction of the South African Boer goat, which has the genes to supply the size, muscling and rapidity of growth for market requirements in a much shorter time than other breeds of goats. The introduction of genes from this breed revolutionised the industry.

When considering breeding meat goats, it is important to decide which market or markets are being targeted. It is vital to research local markets to find available outlets for finished stock, and the local market requirements. It is no use having a hundred wonderful fat wethers of 25 kg dressing weight when the target market may require a dressing weight of 10–16 kg. You can never do too much research. There is a mountain of free information available from many government departments, breed societies, the internet and other breeders.

Farming Meat Goats: Breeding, Production and Marketing is intended to help people setting up a meat goat breeding enterprise from scratch, and current sheep or cattle graziers who would like to have enough information to decide whether it would be profitable to also breed meat goats for the domestic or export markets.

The information contained in this book is intended to help readers set up and manage a profitable goat meat breeding and marketing enterprise. You never know, you may even enjoy it a little along the way.

1

Will breeding meat goats pay?

Before you begin to set up your property for goats or, indeed, any new enterprise, it is essential to do some in-depth research. If it is necessary to obtain finance for your new enterprise, your bank manager will usually want to see a business plan. If you do not have the expertise to create a business plan, TAFE courses held during the year throughout Australia will teach you how.

The first and perhaps most important step is to investigate your potential market. Look at whether your target market is a year-round market, such as the US restaurant trade, or seasonal, such as the Taiwanese market. Enquire about the age and type of stock preferred by each market, and the maximum and minimum numbers buyers will purchase at any one time. Also take into account the distance from your nearest saleyard, abattoir or port.

There are several factors to be taken into account when looking at the costs and inputs of setting up and running a goat meat production enterprise.

1. Distance. The distance to the nearest abattoir should be as short as possible. If goats are on a transport for more then 12 hours, they can become very dehydrated and will lose several kilos in bodyweight. Some goats will die if very dehydrated. Your profit will decrease considerably; in most markets, the price paid for goats is calculated on the hot-dressed carcass weight (HCW). Dehydration can be reduced significantly by transporting the goats at night, when conditions are cooler. Transporting goats at night is therefore good practice in summer.
2. Transport costs. Most companies charge per kilometre, so the longer the distance to the saleyards, abattoir or port of embarkation for the goats, the higher the freight cost.
3. The cost of set-up, including fencing, dams, plant, buildings and stock, must also be considered.

4 In marginal areas subject to dry conditions, will the possible future profit justify the cost of feed and supplements? These can be considerable and must be taken into account. It is useful to look at the average rainfall in the area where you intend to buy land. It is of course more difficult now to estimate rainfall in a particular area, due to climatic change. However, past records will give a rough guide to what can be expected.
5 The cost of labour must be considered. If you are running up to 500 breeding goats, you may need help only occasionally, at drenching, marking (castrating) or tagging times. Frequently, this help is provided by family or friends. If you are running a larger enterprise then you may need more assistance than can be given by family or friends. If so, you will need to employ paid workers and thus the cost of wages, insurance and superannuation will have to be taken into account.
6 Management inputs. These include such things as eartags, footrot shears, vaccines, medications and labour.

These are just some of costs involved in setting up and carrying on a meat goat enterprise. In a goat meat breeding enterprise, the main income usually derives from the meat goats, whether bred for the domestic or export market. However, not all goats sold for meat come from producers who breed exclusively for the meat market. In Western Australia, there is a good export market for capretto (kid meat) where, at the time of writing, 10 000 carcasses are sold into the Swiss market each season. A number of these kids are turned off from Angora goat flocks, either because they are unwanted males or females which do not meet the breeder's standards, or are surplus to requirements.

Another source of income is the sale of replacement does for breeding, or stud bucks to improve bloodlines within a herd. Most producers now breed from full-blood South African Boer bucks, but some are beginning to use Kalahari Red bucks.

The Kalahari Red has a similar appearance to the South African Boer but is mainly red, slightly lighter in bodyweight and longer-legged. They may be a little more resistant to the harsh Australian conditions. The only problem with the Kalahari Red is that it is in very short supply, as there are currently few in Australia.

Selling service from your bucks or hiring them to other breeders can also earn a few extra dollars. It is a good idea to be very cautious about this, because there are several diseases and parasites that can be transmitted. Before we allow our bucks to service a doe or does, we need to know the producer, the herd and the source of its goats. We always thoroughly examine the does to be serviced and, if we have any doubt whatsoever, we refuse service. It is too late for regrets once footrot, coccidia or a contagious disease is introduced into your herd.

Sale of fleece from your goats is another source of income. Because many of the feral goats used as foundation stock in meat goat herds carry good-quality cashmere (as do a number of South African Boer goats), their fleece can be harvested by shearing before shedding season. Shearing is not difficult to learn and classes are held at various properties to teach the technique. There is a good domestic market for cashmere fleece (see the Appendix for contact details of the Cashmere Growers Association).

The sale of goat manure can also be a good extra source of income. If goats are shedded each night, there will a considerable build-up of manure in the pens. This can be regarded as either a problem or an asset. Goat manure is excellent for citrus trees and we have always had

willing buyers for this goat by-product. Citrus growers buy it by the trailer-load and usually do the raking and shovelling themselves. Nurseries that specialise in native plants also buy goat manure, as it releases its nutrients more slowly than chook manure, for instance.

A more accurate way to calculate whether it will be worthwhile and profitable to breed meat goats is by calculating a gross margin for your proposed enterprise.

The following DPI and Fisheries Note is reproduced with the kind permission of Department of Primary Industries and Fisheries Queensland and the authors (Cathcart et al. 2001).

Calculating a gross margin for sheep, goat and cattle enterprises

Introduction

When establishing a new enterprise, it is important to consider the economic value it will contribute to the whole business. A quick way to assess the performance of a new livestock enterprise is to calculate a gross margin.

This DPI note is a guide to calculating the gross margin. A gross margin enables producers to evaluate their existing enterprise performance; for those who are contemplating investing in a new enterprise, it provides a guide to estimating a gross margin.

A gross margin is the value of enterprise output (comprising inventory changes and net livestock trading) less the variable costs attributable to the enterprise. This allows comparison to be made between enterprises, for example sheep, goats and cattle.

The gross margin does not measure profit. It shows the contribution of each enterprise to fixed costs, interest and capital expenditure. Therefore, enterprises can be compared on the basis of their gross margins, provided fixed costs are the same.

How to calculate a gross margin

You can calculate the gross margin for a flock or herd that changes in size between the start and end of the year – as happens in most flocks or herds in most years – in the following way.

Gross margin = value of enterprise output – variable costs
Gross margin = (net trading[1] + inventory change[2]) – variable costs

[1] Net trading ($) = sales – purchases
[2] Inventory change ($) = (closing number – opening number) x per head market value

Note: if the flock is in a 'steady-state' situation (opening and closing inventory are the same), the value of output from the enterprise is the value of net animal trading. If the enterprise is not steady-state, change in inventory must be accounted for.

Other terms that you need to be familiar with include:

- variable costs – those that vary directly with the number of stock. This includes animal health, fodder, livestock freight, eartags, selling costs and some contract labour such as mustering;
- fixed costs – those that do not vary with the number of stock run. Examples of fixed costs are accountancy, electricity, insurance (general, not livestock), repairs and maintenance, fuel and oil, rates and rents, operator's labour allowances;
- dry sheep equivalent (DSE) – the nutritional requirement of a 50 kg dry (non-lactating) sheep. This enables different classes of animals to be compared on a common basis.

Gross margin can be expressed in a number of ways. Gross margin per DSE is a useful means of comparing grazing enterprises against each other, such as goats compared with sheep and cattle.

To enable comparisons to be made between enterprises with different capital requirements, gross margin per $100 of livestock capital is used. It should be calculated as part of every gross margin analysis because it helps the grazier decide the best use of limited capital.

Information used
Below are the production and financial information requirements for calculating a gross margin. They also form the basis of assumptions for gross margin calculations.

Production information
This includes:

- number and value of livestock sales;
- number and value of livestock purchases;
- opening and closing inventory;
- deaths and rations.

Variable costs attributable to livestock include:

- animal health;
- fodder;
- livestock freight;
- selling costs;
- some contract labour, such as mustering.

The accuracy of these variable costs depends heavily on the records kept by the producer. When expenditure on variable cost items occurs, it is imperative that producers record which enterprise it is attributable to.

Example of gross margin calculation
Below is an example of how to set out a gross margin calculation. It is important to specify each class of livestock (bucks, does/cows, claves, weaners/ewes, lambs etc) when calculating income and costs.

Table 1.1 DSE ratings for Merino sheep

Class of animal	DSE ratings for average weight					
	20 kg	30 kg	45 kg	50 kg	55 kg	60 kg
Ewe >1 year & lamb			1.3	1.4	1.6	1.7
Wether >1 year			0.9	1	1.1	1.2
Weaner <1 year	0.9	1.1				
Ram					1.5	

Source: Woolmark Company (1999)

Table 1.2 DSE ratings for crossbred sheep

Class of animal	DSE ratings for average weight			
	30 kg	40 kg	60 kg	70 kg
Ewe & unweaned lamb			2.0	2.4
Wether <1 year	1.2	1.7		
Ram			1.5	1.7

Source: Woolmark Company (1999)

Current best practice suggests that DSE ratings for various classes of goats are similar to Merino sheep. The DSE calculations for goats can be performed using Table 1.1.

With horses, ponies have a 9–11 DSE and mature horses 10–14 DSE (Seaman and Marchant 1998).

Table 1.3 DSE ratings for beef cattle

Class of animal	DSE ratings for average weight							
	200 kg	300 kg	400 kg	450 kg	500 kg	550 kg	600 kg	800 kg
Cow & unweaned calf				14.5	16.1	17.7	19.3	
Dry cow				6.8	7.5	8.3	9.0	
Weaned calves < 1 year	6.1	7.9						
1–2 years heifers		8.1	10.8	12.2				
1–2 years steers		8.1	10.8	12.2				
2+ years steers			10.8	12.5	13.5	14.9	16.2	
Bulls							14.4	18.0

Source: Woolmark Company (1999)

Table 1.4 Calculating a gross margin

Income					
	Number	**kg/head dressed**	**$/kg dressed**	**$/head on farm**	**Total**
Livestock sales					
				Total sales (A)	
	Number	**$/head**			
Livestock purchases				Total purchases (B)	
				Net sales (C = A – B)	
				Inventory change (D)	
				Value of enterprise (E = C + D) output	
Variable					
	Number	**$/head**			
Dipping				Total	
Drench				Total	
Vaccine				Total	
Supplement				Total	
Tags				Total	
	No. of days	**$/day**			
Casual labour				Total	
	Number	**$/kid**			
Marking				Total	
Selling costs					
	Average no./ deck	**$/deck/km**	**Average km**		
Freight				Total	

No. sold			
Commission %			
	Number	**Cents/head**	
			Total
			Total variable costs (F)
			Gross margin (G = E – F)
			Gross margin/ha
			Gross margin/$100 of livestock capital

Selecting and preparing the property

Before you buy a single goat, or accept some as a gift (as we did), you must select the land, put in appropriate fencing and shelter and ensure that there is an adequate supply of good clean water available in all paddocks.

Goats can be run on many types of country and have been successfully grown, harvested and marketed for meat from the inland of Australia to the coast. Each environment has its advantages and disadvantages.

Land for keeping goats does not have to be top grazing country; if it has some shrubs and weeds, so much the better. Goats are browsing animals that appreciate a mixture of shrubs, woody weeds, herbs and different pasture types. They are very fond of wattle, mulga and Brigalow scrub, for instance. If cattle and sheep can be run on your property, you can usually run goats successfully. Goats can also be run on country that is to steep or rocky for other types of livestock, which is useful if you have areas that are otherwise unproductive.

There is one type of country that may not be suitable for goats. If the country is very wet or boggy, you may experience problems with the health of the goats, including, liver fluke and foot problems. If foot rot is introduced, for example from new stock infected with the bacterial organisms *Fusiformis nodosus* or *Spirochaeta penotha,* the wet conditions will allow the bacteria to thrive. Footrot is found most frequently in the southern states of Australia during warm and damp periods in spring and autumn. Footrot is not regarded as a significant problem in Queensland (www.aahc.com.au).

Fencing must be suitable for goats. Fencing that is suitable for cattle is merely a temporary hindrance to goats – it usually stops them for about five minutes!

A ready supply of good clean water is the next requirement. Goats will drink up to 12 L of water a day in summer, more during lactation.

It isn't necessary to have shelter for goats, but it helps to keep them in better condition if they have somewhere to shelter during very cold and wet conditions.

You will need to set up some yards and a race where you can work with goats for drafting, marking, drenching and foot trimming etc. Existing cattle or sheep yards can often be easily adapted for goats, as can fencing.

Goats and cattle will graze quite happily side by side; in fact, cross-grazing with cattle will lower goats' worm burden. This will be explained more fully in Chapter 10.

If you are planning to obtain income solely from goats, you will need at least 1000 breeders. Most graziers do not have enough land for this, but a very nice additional source of income can come from adding a few hundred breeders to your existing enterprises, such as running cattle or sheep. It is vital that the nearest abattoir, export depot or saleyard is close enough that transport costs remain affordable.

A common question is 'How many goats can be run per hectare?' This depends upon the type of country and availability of feed and water. Our own experience and consultations with other breeders show that a good stocking rate is running 5–7 goats where one head of cattle could be run. It is always a good move to consult with the extension officer at your local state or territory agricultural department (or its equivalent) about suggested stocking rates for your area.

2

Fencing and yards

We erect fencing not only for the obvious reason of keeping stock where we want them to be rather than where they would like to be, but also to keep predators away from stock, to separate different classes of stock, to keep stock away from dangerous areas and to facilitate rotational grazing.

There are several types of fencing suitable for goats. As mentioned in Chapter 1, cattle fences may be adapted for goats. The three main types of fencing used to contain goats are plain wire electric fencing, fences using any of a number of different types of commercial mesh, and mesh with electric plain wire outriggers. There are advantages and disadvantages with each type of fencing and some problems are easier to overcome than others. We have found a combination of mesh with outriggers to be very effective when training goats, especially bucks and kids, to electric fencing. A young kid can often be seen skipping in and out of fencing while its mother is frantically running up and down the inside of the fence. An offset electric wire set on an outrigger 13–14 cm from the ground on the inside of the fence will soon take care of that problem!

Electric fencing

How an electric fence works

An electric fence works by delivering a harmless but unpleasant electric shock to any animal contacting the fence. This is achieved when the animal contacts the wire or wires in the fence and becomes part of the circuit between the positive and the earth terminals of the energiser.

One of the simplest and most effective electric fences is a four-strand barbed-wire cattle fence with two plain live wires and one plain earth wire added, to give a total of seven wires.

The first wire at the base of the fence is a plain non-barbed earth wire, set 75 mm above the ground. The next wire is a live wire set halfway between the earth wire and the first

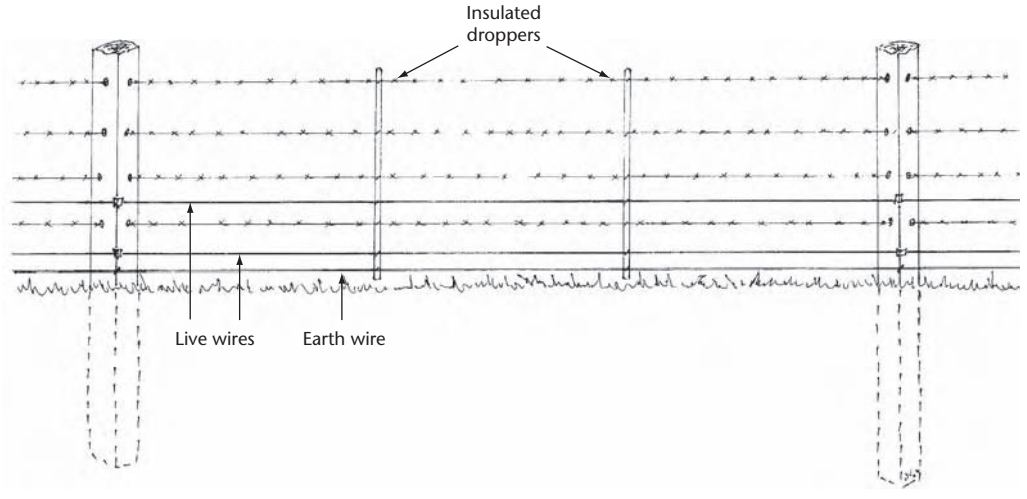

Figure 2.1 Converting a barbed-wire fence to electric

barbed wire. The other live wire is run between the next two lines of barbed wire. Goats rarely escape from a paddock set up like this (see Figure 2.1).

The live wires on an electric fence that is required to contain goats within a paddock need to be run at 5 kV (5000 volts) or more, which delivers a nasty sting. Below this voltage, many goats will take the shock to get to where they want to go: the other paddock where, as we all know, the grass is always greener. **Note: fences carrying more than 3 kV may adversely affect some horses.**

A word of warning: never energise barbed wire. It is extremely dangerous and could even kill a child or elderly person if they were caught on it as, if the barbs broke the skin, the shock could be greatly intensified. The Department of Primary Industries & Fisheries (Qld) advises that industry best practice is not to energise barbed wire. The office of the Telecommunications Ombudsman also suggests that it is unwise to energise barbed wire, although doing so does not seem to be illegal.

Electric fencing can be reasonably fast to erect and costs less than mesh fencing to erect. Mesh fencing often does not deter foxes as they will frequently force their way through, or climb, mesh to get at newborn kids.

There are several ways to set up an electric fencing system and there are three basic types of energiser systems.

1 Bipolar – half the wires on the fence carry a positive charge and half carry a negative charge. Any wire touched by an animal will deliver a shock. If an animal touches both types of wire at the same time it will receive a double-strength shock because it completes the circuit in two ways: via the earth return system and via the fence return system, where the animal becomes part of the circuit – the flow travels from the positively charged wire through the animal and back to the energiser through the negatively charged wire. One problem with bipolar systems is that of grass and other vegetation contact wires and earth the fence, especially in damp conditions.
2 Fence return – the wires on the fence are arranged as earth and live alternately from the bottom wire to the top. An animal completes the circuit when current from the

pulsed (energised) wire flows through it and back to the energiser. In very dry conditions the animal has to contact both an energised and an earth wire to receive a shock, but when there is good moisture in the ground the animal need only touch the energised wire to receive a good deterrent shock.

3 Earth return – this uses one or two wires (or tape) to deliver the pulse from the energiser. An animal completes the circuit when it contacts the live wires. It is commonly used for strip grazing but it is completely useless for goats because they simply jump over or crawl under the tapes or wires.

These systems may be:

- mains-powered – the energisers usually require low or no maintenance;
- battery-powered – the batteries need to be charged quite often but the system has the advantage of easy portability;
- solar-powered – where a more powerful portable system is required. Solar-powered energisers are especially suited to remote areas where there is no electricity supply available to run a mains-operated energiser or where there are no facilities to recharge batteries. Manufacturers of solar-powered electric fencing systems recommend that deep-cycle batteries be used. This type of battery copes better with the trickle charge from solar panels and occasional sudden power draws, such as when stock or other animals contact the fence.

Your electric fence earthing system should be located at least 10 m from telephone cables and should not run alongside them for more than 200 m if possible. Telstra can give advice on this or information can be found online at www.telstra.com/countrywide.

If you or your neighbours hear clicking in the telephone or the internet connection keeps dropping out, there is probably a fault in the electric fence. This could be due to a number of reasons, including a live wire and earth wire twisted together, a branch or tree on the line, a broken insulator or wire, or perhaps, after rain, long wet grass or vegetation contacting a live wire causing the fence to earth. This is not only inconvenient but it also means that your goats can get out and the predators can get in.

A good-quality fence tester is necessary for electric fencing. There are several types of testers available, the simplest of which has three lights on its face, each lighting up to show a different voltage range. The more sophisticated digital types show the actual voltage and top-of-the-range voltmeters actually show the direction of the fault via an arrow on the display, which can be a great time-saver.

A number of companies manufacture and market fence energisers and testers, wire suitable for electric fencing, insulators, droppers, in-line tensioners and many other specialised types of equipment which have been specifically developed for this type of fencing. Local feedstores and rural suppliers are usually very helpful and will obtain information on fencing if asked. Most of the companies that manufacture energisers and fencing supplies also produce booklets with detailed diagrams and instructions on setting up fencing and these are usually free.

Another good source of information is the annual local agricultural show, where there are usually representatives from major fencing companies. These companies produce

excellent step-by-step guides to the different types of fencing systems and their representatives will tailor a system for your needs.

Primary Industries or Agricultural Department extension officers are also a very helpful source of information and advice. We have always found them happy to help. Representatives of these departments usually attend agricultural shows, or can be contacted during regular office hours.

Plain wire electric fences

Several companies manufacture wire specifically for electric fencing systems. The thickness of the wire varies, but it is usually 2.5–2.8 mm. The price and length of each roll of wire varies according to type and thickness. Better-quality, flexible high-tensile wire should be chosen even though it is a little more expensive. Some cheaper imported high-tensile wire is very stiff and difficult to work with, and is more prone to stretching, rusting and breaking than the better-quality types.

Each type of wire has a different tension to which it must be strained for maximum efficiency; you must request this information when purchasing it.

Fence construction

Spacing the wires

The spacing of wires on an electric fence intended to contain inquisitive and agile goats is very important. If the wires are too far apart, a goat attempting to go through a fence may slip between a gap in the wires without receiving a deterrent shock. Correct spacing is particularly important on a fence return system because, if conditions are dry, a goat will only receive a shock if it contacts two wires. Figures 2.2 and 2.3 show suggested spacing of

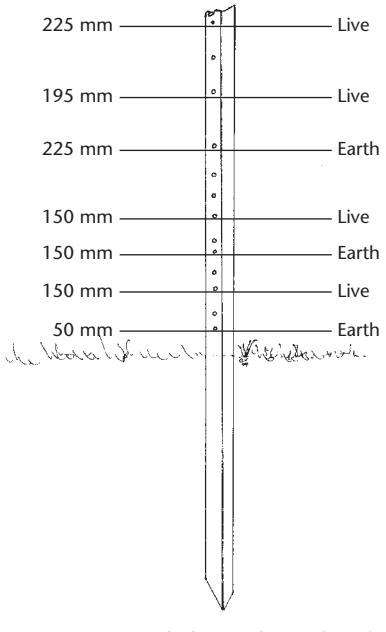

Figure 2.2 Spacing of wires on a seven-strand electric boundary fence

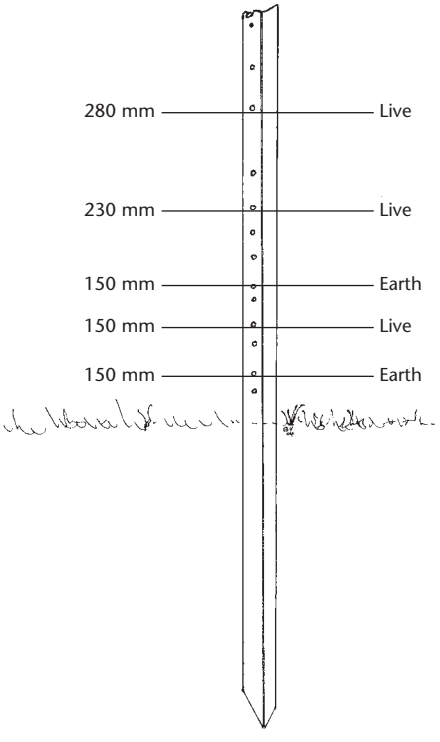

Figure 2.3 Spacing of wires on a five-strand electric paddock fence

wires on electric fences. Spacing should be adjusted to suit various commercial steel posts because spacing of post holes varies between manufacturers and height of posts.

The two most common types of post are steel posts (commonly called 'star pickets') and wooden posts. Ironbark posts will not need insulators on live wires, but if some other types of timber or if steel posts are used then each live wire must be insulated. Strainers (also known as corner posts or end-line posts) are usually wooden with a diameter of 15–20+ cm or, less commonly (because of cost), heavy galvanised steel fence posts. Steel strainer posts must be concreted in.

Wooden strainer posts should be 2.4 m long and split posts 2.2 m long. These posts should be set at least 90 cm into the ground. Fill the soil back into the hole around each post a little at a time, tamping each layer of soil down well. The end of a fencing bar is the ideal tool for this. A fencing bar is similar to a crowbar, but with a very useful flat top. If all the soil is placed in the hole at once and then tamped down, the top layer will be compacted but the lower part will not; the post will eventually become loose because it is not held firmly.

In difficult terrain where there is traprock or similar close to the surface, it may not be possible to sink posts to the recommended depth. Sink support posts as deeply as possible; for strainer posts, use bed-logs and stay posts, or concrete them into their holes.
If strainers are not stabilised properly they will eventually lean sideways, due to the tension of the wires, and the fence will become slack. Slack fence-wires allow stock to get out and predators to get in.

Another problem occurs if there is very sandy soil or damp areas: if the soil is soft, the pull of fencing-wire on the strainer posts eventually pulls the posts sideways and slackens

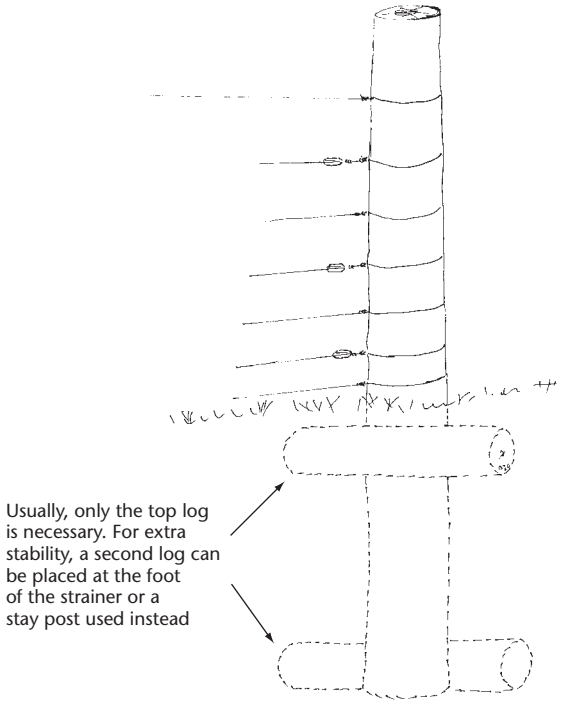

Figure 2.4 Bed-logs

the wires. Horizontal tension is vital. One solution is the use of bed-logs buried at the base of each strainer. Extra droppers (wire-spacers) can also be added between posts, to keep the wires at the correct distance from each other. The bed-logs do not need to be large; one or two sections of post offcuts 60–90 cm long for each strainer should be ample (see Figure 2.4).

The distance between posts should never be more than 20 m, and 15 m gives a more secure boundary fence. Two droppers should be placed between each post to help prevent twisted wires, caused by kangaroos etc. crossing the fence. These should be placed 6.6 m apart for fences with posts 20 m apart and 5 m apart for fences with posts 15 m apart.

For gully crossings, the distance between posts must be reduced to prevent posts being pulled up and out of the ground, due to tension from the wire, and to reduce the gap beneath the fence. If the gap under the fence is too high then stock may get out or vermin get in. Place posts on either side of the gully, not in the middle, to help prevent them being ripped out by floating debris if the gully floods during heavy rain.

On our own farm, when constructing a fence to contain bucks not required for work, we spaced posts 9 m apart and put droppers (wire-spacers made of ironbark) 1 m apart. We also used seven strands of 2.5 mm high-tensile plain wire, because a buck that scents a female in season is very determined indeed. Even faced with such a sturdy fence, bucks may still escape. The most secure fencing for a determined buck consists of steel panels made from 2 mm thick galvanised tubing; better still, a paddock as far from cycling females as possible, with at least one paddock between them.

There are various types of droppers but obviously, with electric fencing, they must be of non-conducting material such as ironbark or commercial plastic.

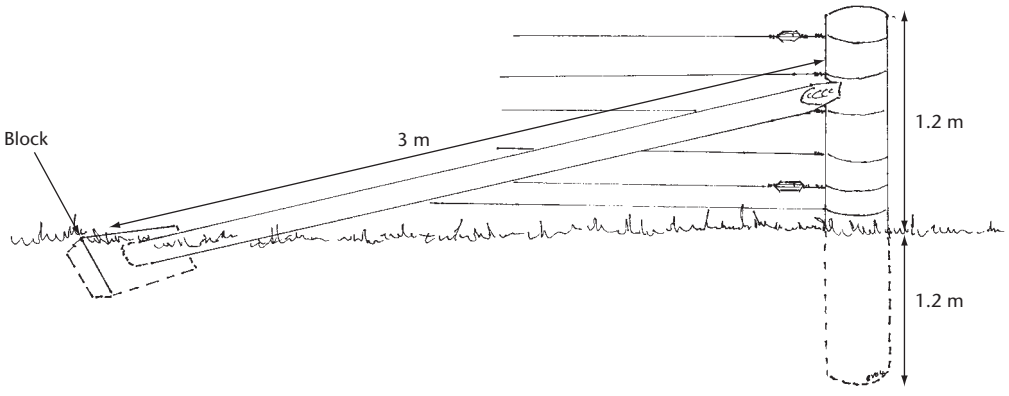

Figure 2.5 Strainer assembly

Strainer assembly and stay post

Each strainer post will need a stay post to help take the strain of the fence line. Stay posts should be 2.75–3 m long and shaped at the top to fit a mitre cut into the side of the strainer post so that they cannot ride up the strainer post. This mitre should be two-thirds the height of the post from the ground – no higher, or the stay post will act as a lever and push the post upwards and out of the ground. If the cut is too deep it will weaken the strainer post. A footplate made of a 60–90 cm section of old railway sleeper or similar, for the lower end of the stay post to rest against, should be driven into the ground if the soil is soft, at an angle perpendicular to the end of the stay post. This footplate will help keep the strainer tight against the post. If the soil is hard, a trench must be dug for the footplate. Care must be taken when setting the stay post in harder soil.

1 Cut the stay post to the correct length and mitre the end.
2 Trace the shape of the mitred end onto the strainer post at the correct height and cut this out.
3 Place the end of the stay post into the mitre on the strainer post and put the footplate on the ground, square against the lower end of the stay post. Note the angle.
4 Dig a trench at that angle and place the footplate into it.
5 Rest the stay post on top of the footplate and check the length. If there is more than 2–3 cm overhang, trim the excess.
6 Using a crowbar, lever the stay post down into position against the end of the footplate.
7 Fill in the trench and firm down.
8 When straining the fence, hit the strainer post on the opposite side to the mortise to make sure that the stay is tight into the strainer (see Figure 2.5).

Timbers suitable for posts are ironbark, messmate, stringybark and redgum. Ask local farmers about other timbers that can be used for fencing.

Using bridges to join the earth and energised wires

To join the earth wires to each other and the energised wires to each other in an electric fence, bridges must be created using insulated lead-out cable. Most producers use

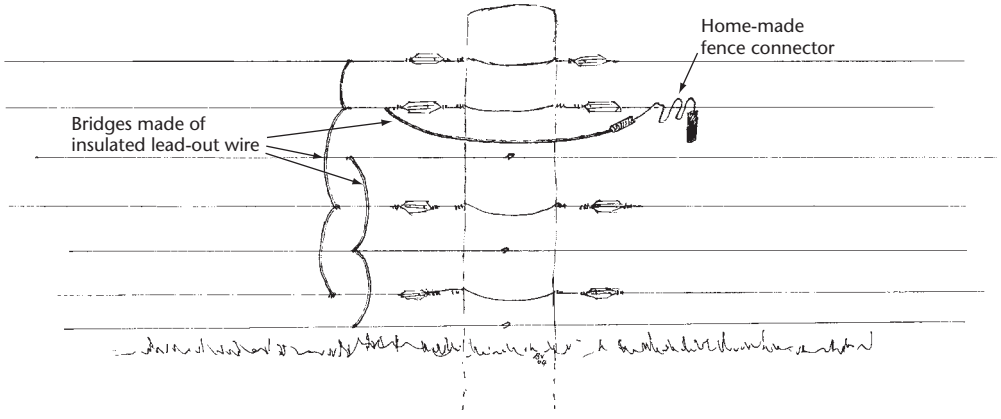

Figure 2.6 Bridges on lines and strainer posts

commercial cable but an inexpensive substitute can be made by running lengths of fencing wire through sections of garden hose.

Wires also need bridges of insulated cable to bypass strainer posts. There are commercial clips for attaching these bridges to fencing wires but they can also be attached by simply wiring them onto the fence. To do this you will need to strip 5–6 cm of insulation from the end of each bridge.

To create the bridge, strip the insulation from the wire's end while it is still on the roll. Attach this end to the first wire in the series to be joined, using fencing pliers, and take three turns of the bare lead-out wire around the fence wire. Make sure that it is tightly wired on, to ensure good conductivity. Unroll enough cable to reach the next wire in the series and, allowing an extra 10–15 cm for wiring it on, cut this length from the roll, strip the end and wire it on as before. When using joining clips, follow the manufacturers' instructions (see Figure 2.6).

Fence connectors

Sometimes locating a fault on the fence can be difficult, but the use of fence connectors (also known as cut-out switches or line isolators) at the end of each line, at gates and where two lines of fence meet, can make the job much easier, as they allow a section of fence to be isolated from the rest of the line. Fence connectors also make it easier to work on the fence without receiving a nasty shock if you touch a normally energised wire. There are excellent commercial fence connectors, but you can easily make your own using garden hose and fencing wire (see Figure 2.7).

Energised wires must be insulated from strainer posts using bull-nosed plastic or ceramic bull-nosed or cotton-reel insulators. The non-energised space between insulator and strainer post should not be more than 15–20 cm, or stock will fit through the space. If the fence is longer than 25 m it is advisable to use the larger plastic 8 cm bull-nosed insulators on the strainer posts, as the smaller ones can break under the strain on long sections of fence. In-line ratchet-tensioners can also be used; there are insulated ones for energised wires and non-insulated ones for earth wires. The initial expense can be high, but in the long term they will save a lot of time and effort. Using in-line ratchet-tensioners to adjust the tension of the fence takes only a minute or two, whereas the conventional way of tensioning fence wire using wire strainers can take several minutes.

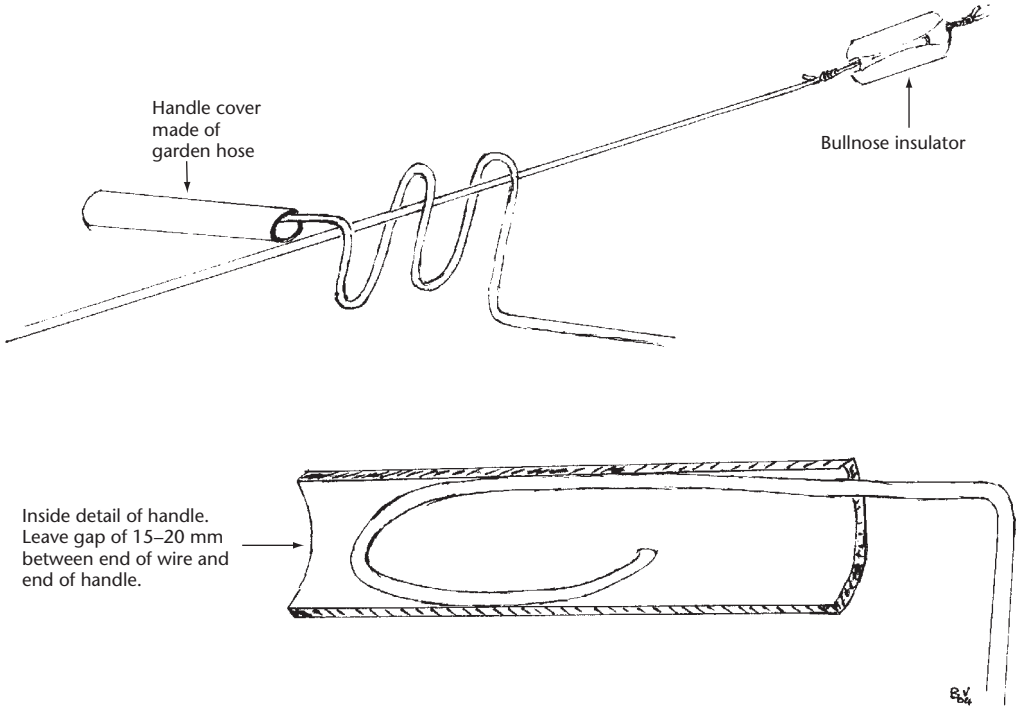

Figure 2.7 Home-made fence connector

Corner assemblies and box assemblies

Goats and predators sometimes gain access to paddocks by using stay posts as bridges over the fence. Using corner assemblies and box assemblies instead of strainer posts can eliminate this problem, as they have no stay posts for animals to climb. Corner assemblies and box assemblies also withstand the strain produced on long runs of six- or seven-strand fences.

A corner assembly consists of three posts set approximately 3 m apart with two capping rails with mitred ends fixed on top of them, joining the three posts to make a 90° angle. A double-twisted stay wire is run from the top corner of each outer post to the base of the corner post; the stay wires may need to be insulated. The posts are notched shallowly to prevent the wires moving out of position and the mitred capping rails are wired or bolted into position. This, along with the stay wires, keeps the posts from moving out of position (see Figure 2.8). These corner assemblies last many years if constructed correctly; some on our property have been standing for over 20 years and are still in good condition.

Box assemblies are commonly used where there is a gate. They consist of two posts approximately 3 m apart with a mitred capping rail across their top. The stay wire is run from the top of the post furthest from the gate to the bottom of the post on which the gate is swung.

In all the years that we have been breeding goats we only ever had one goat that consistently climbed stay posts; he was culled, because other goats in a herd will soon learn to copy such bad habits.

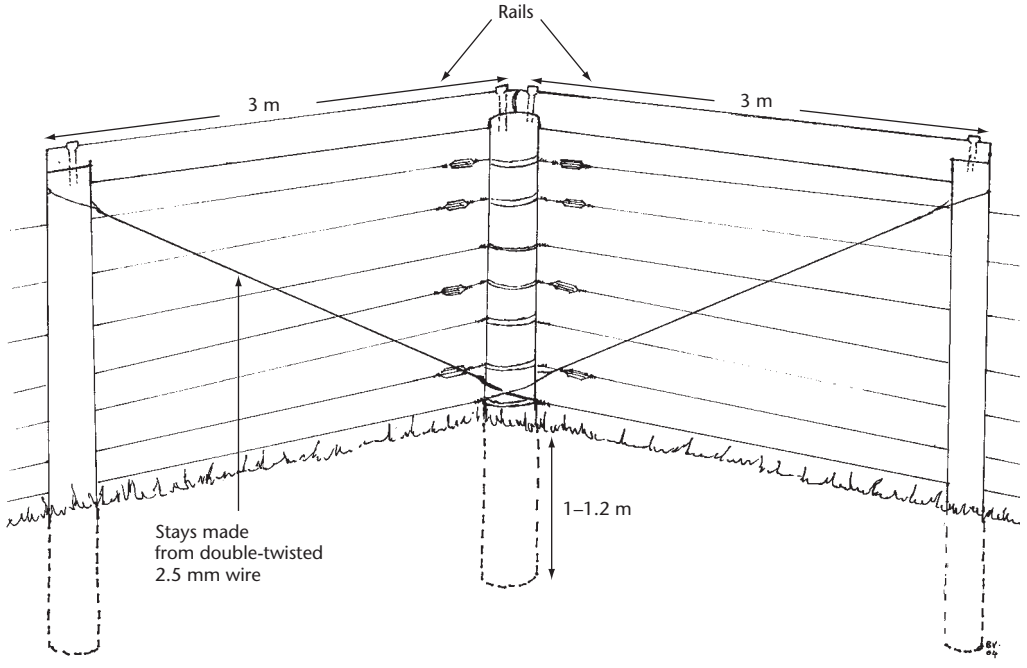

Figure 2.8 Corner assembly

Earthing the fence

A good earthing system is essential if electric fencing is to work efficiently; many of the problems encountered with electric fencing are due to poor earthing. If the earth terminal of the energiser is insufficiently earthed an animal will not receive enough deterrent shock.

The energiser should be in a sheltered location; in a mains-operated system it is usually in a shed. The insulated cables (one from the live terminal and one from the earth terminal)

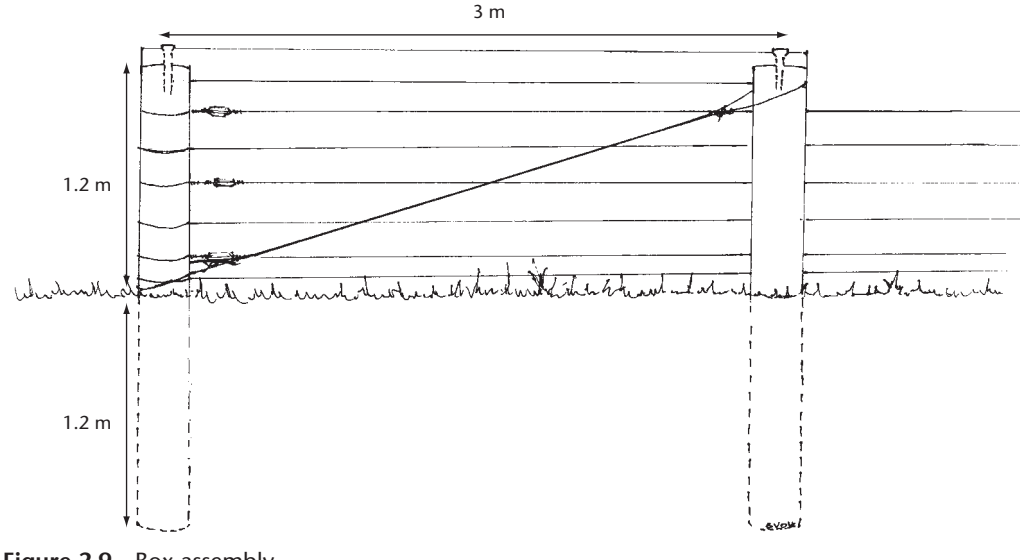

Figure 2.9 Box assembly

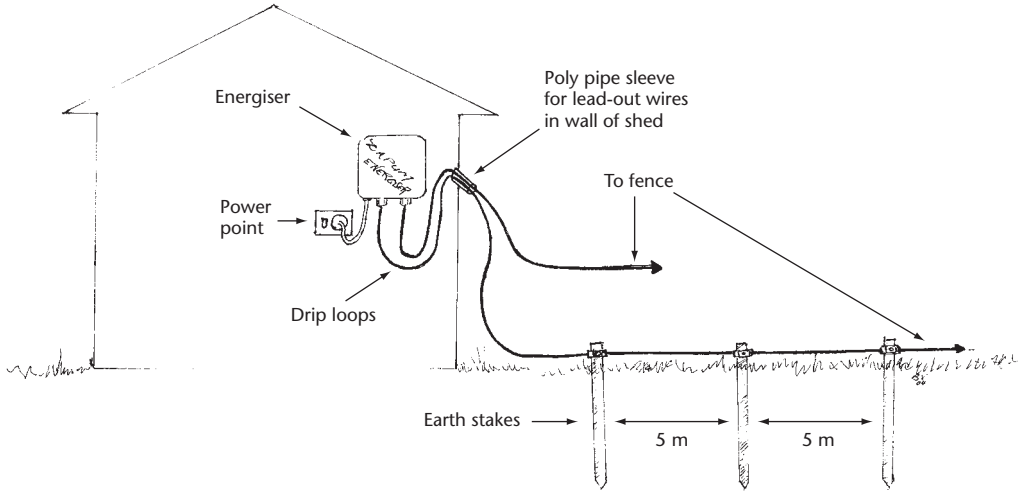

Figure 2.10 Location of energiser and earth stakes

that will be joined to the first live wire are carried through the shed wall in a sleeve of poly pipe or rubber hose. From there, the earth wire is joined to a series of three earth posts made of stainless or galvanised steel and then to an earth wire on the fence. Our galvanised steel star pickets have been in place for 22 years and are still working well.

The earthing stakes are driven 1.5 m into the ground and are set 5 m apart. The earth cable must be buried, as that way there will be less chance of stock or people accidentally ripping it off the earthing stakes. If possible, the earth stakes should be set in moist earth, or where the ground can be dampened in dry periods to create a good earth (see Figure 2.10).

In dry country or on very long runs of fencing, it is good practice to earth the fence in several places to help maintain a good earth along the whole length of the fence. The earth stakes should be driven 1.5 m into the ground and earth wires connected to them using a standard bridging system. These extra earth stakes should be placed at a distance of 1.5–2 km along the fence. Do not put your earth stakes within 10 m of your household earth. It is advisable to put a lightning arrester kit between the energiser and the beginning of the fence because long lines of fence often receive lightning strikes during an electrical storm, resulting in severe damage to the energiser. The kits are not very expensive and have full instructions for installation.

In very dry conditions, a good earth may not be achieved due to lack of moisture in the soil. A good earth may be created and maintained with a mixture of two parts bentonite to one part coarse salt (coarse stock salt would be suitable), made into a runny paste with water. Sink a hole approximately 90 cm deep and 10 cm wide and put a stainless steel (salt will corrode ordinary steel) earthing rod into the hole. Pour the mixture around the post in the hole, fill in and firm the soil. Connect the post to the earth wire in the usual fashion. The salt attracts water and the bentonite retains it, thus creating a good earth. Some producers have found that bipolar energisers, where all wires can deliver a shock, are more effective than the fence return system where, in very dry conditions, it is difficult to get a good earth.

Run the energised and earth lines under a gate inside poly pipe buried approximately 20 cm deep to protect the lines from stock and vehicles. The poly pipe must be long enough to

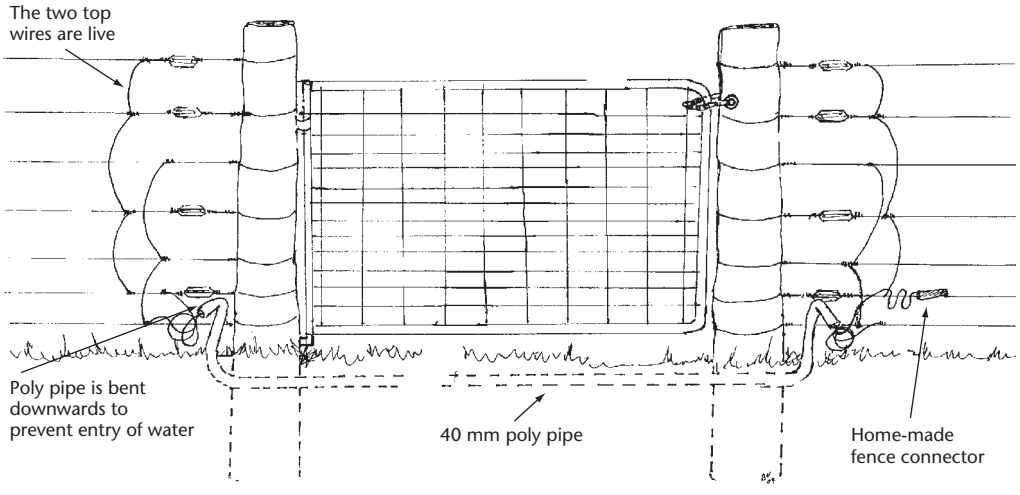

Figure 2.11 Carrying lines under a gate

allow the cables to remain insulated until they are joined, on the other side of the gate, to the first live and the second earth wires respectively, or any corresponding wires that are high enough above the ground to keep them clear of water. Make a loop of about 30 cm on each end of the lead-out cable to allow it to be reattached to the fence if the end of the lead-out cable snaps off. The poly pipe should be folded downwards for 15–20 cm at each end to prevent water entering it and becoming trapped (see Figure 2.11).

Testing the fence

To test the fence, connect one clip of the voltmeter to an earth wire and one clip to a live wire; for bipolar systems attach one clip to a positive wire and one to a negative wire and follow the manufacturer's instructions for the reading the voltmeter and locating the fault. To test the earth stakes along the fence, take a normal reading on the fence then attach one clip of the voltmeter to an energised wire on the fence and one clip to the earth stake. If the readings vary by more than 200 volts, extra earthing stakes need to be used. If possible, these should be located where there is more moisture in the soil. In very dry conditions, it may be necessary to use the bentonite/salt mixture with stainless steel earthing rods, as previously described.

Joining broken wires

From time to time a wire will break, due to animal impact from stock or kangaroos, or some other cause. The section of broken fence should be isolated from the rest before you rejoin the wires, so that you can work on the fence without worrying about receiving a shock. After the wire is repaired, you will have to re-tension the line to the manufacturer's specifications. With ratchet tensioners, this will take only a minute.

It is most important that the knots used to join wires will not allow other fence wires to catch on them. Figure 2.12 shows the two most commonly used and easiest knots. Make sure that all long tails are trimmed after the knots are tightened so that they do not catch other wires in them.

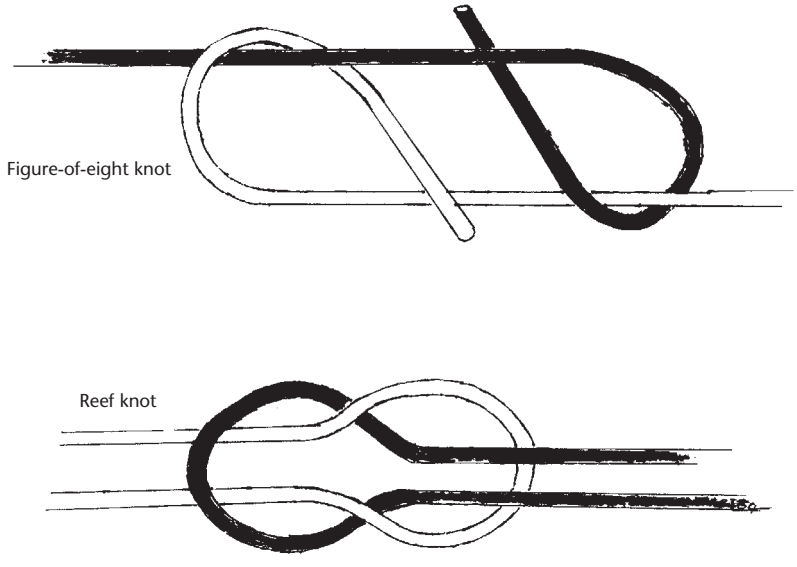

Figure 2.12 Fencing knots

Electric fence safety

- Mains-powered electric fence energisers should always be installed in a sheltered place such as a shed.
- Avoid crossing your electric fence under power lines, but if it cannot be avoided the fence should cross under the power line as near as possible at a right angle. The stronger current in the power line may affect the efficiency of your fence.
- If the fence is in an area where members of the public are likely to touch it, it should always be identified with a yellow electric fence warning sign.
- Try to keep the fence well away from telephone lines as the pulsing can result in severe interference with telephone lines.
- Do not energise barbed wire, as it can be extremely dangerous to children and elderly people if they become caught on it.

Mesh fencing

Some producers have found that if goats are very quiet, a simple hinge-joint fence is enough to keep them in their paddock. The recommended hinge-joint fencing for goats is 8/90/30 size mesh, which avoids the problem of goats becoming hung up in the mesh.

The code for sizing of hinge-joint fencing is quite simple:

- 8 = 8 horizontal wires
- 90 = 90 cm high
- 30 = 30 cm mesh spacing.

On our property, we have found that hinge-joint or mesh fencing is not very successful unless we include two offset lines mounted on outriggers. This is probably because our commercial herd was of feral origin, and fairly wild. The two outrigger-mounted lines are

Figure 2.13 Young doe caught in mesh fence

live. The first is set 12 cm above the ground and the second 75 cm above the ground. A paddock fenced with hinge-joint fencing and outriggers makes a good training paddock for kids and newly introduced goats that are unused to electric fencing. Suppliers will give information on constructing a fence using hinge-joint mesh.

Figure 2.13 shows the problem of using mesh smaller than 30 cm. Because their horns face backward, goats can put their head through the mesh but then cannot withdraw it. If a goat trapped in this fashion does not die of thirst or exposure, it is often killed by other goats because they will take advantage of its helplessness to butt and shove it.

Hinge-joint or other mesh that is graduated from smaller (approximately 10 cm) mesh up to around 20 cm seems to create the worst problems of goats being hung up. This is because when they are kids they can fit their heads through this type of mesh to eat grass on the other side; when their horns begin to grow the problem of them being hung up in the mesh starts to occur.

Note: to avoid breaking your fingers when removing a goat that is stuck in a mesh fence, always remove them while standing on their side of the fence and ease one horn at a time back through the mesh. Goats are not known for their gratitude, and will usually go off upon release without so much as a backward glance, while you nurse your bruised knuckles!

Dairy goats that have been dehorned do not suffer from the problem of getting trapped.

Yards

If more than a few goats are being run, you will need to construct a good set of working yards for such operations as drenching, tagging, vaccinating and drafting animals for sale.

Because this book is concerned with the breeding of meat goats on-farm, we have not included designs for trapyards, which are used to trap feral goats. Briefly, however,

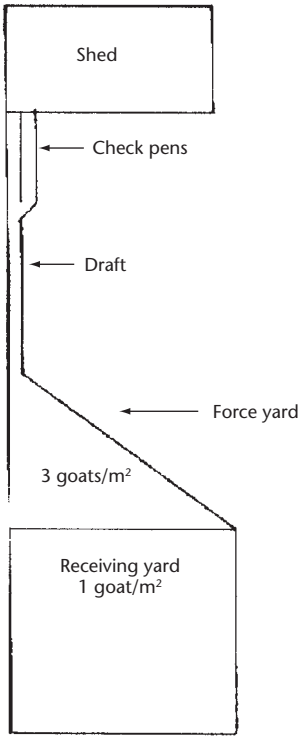

Figure 2.14 Yard for a small herd of goats

Source: Armstrong et al. (1993). Reproduced with kind permission of Dept of Primary Industries & Fisheries (Qld).

trapyards work by enclosing the only available watering points within yards leading to drafting yards and loading chutes. When feral goats come in to drink the gates are shut on them. These yards save much time, money and effort, as they remove the need for mustering. There is quite a lot of information about this subject online, at the various Departments of Primary Industries' websites (see Appendix 1).

The size of yards and holding paddocks will vary according to the number of goats to be handled in them. Figures 2.14, 2.15 and 2.16 show three different designs for yards. Yards should be set up to make the movement and handling of stock within them as smooth, safe and fast as possible. They should also be constructed so that stock suffer minimal stress when they are being moved or handled there.

It is especially important that stock which is being sent to slaughter is handled as quietly and efficiently as possible. Goats are quite different from sheep – they are more flighty and stress more easily. Because of this, dogs should not be used in the yards for driving goats. Animals that are severely stressed in the yards can die in transit, especially when the stress of transport is added. Stressed animals also produce darker and tougher meat due to metabolic processes.

It is best to locate your yards on flat ground, although a slight slope can be desirable to allow for drainage in wet conditions. If the land is not reasonably flat, the yards should run across the slope. Do not construct the yards so that goats will travel downhill, as they may be reluctant to move through the yards freely.

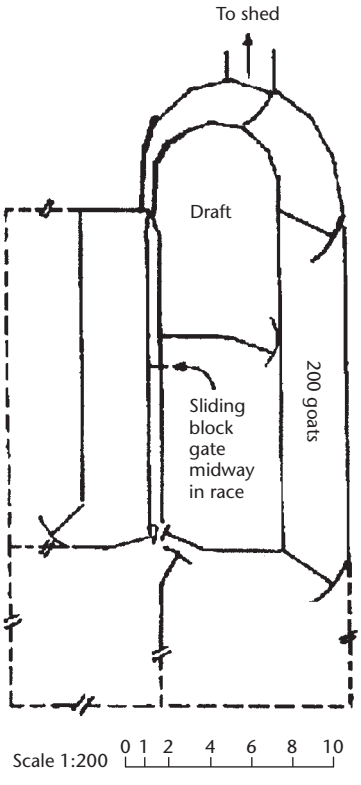

Figure 2.15 Bugle-shaped yard with a long approach

Source: Armstrong et al. (1993). Reproduced with kind permission of Dept of Primary Industries & Fisheries (Qld).

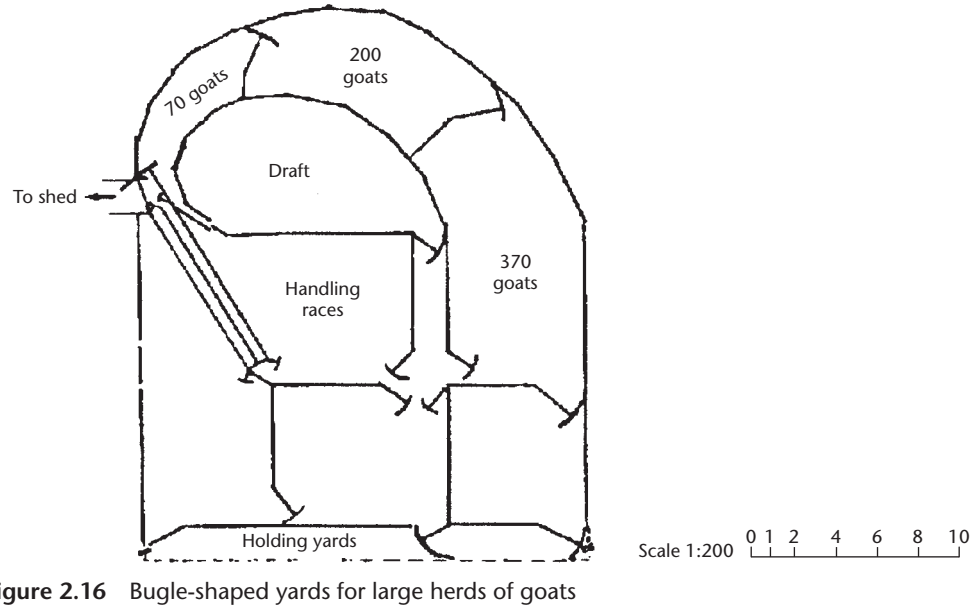

Figure 2.16 Bugle-shaped yards for large herds of goats

Source: Armstrong et al. (1993). Reproduced with kind permission of Dept of Primary Industries & Fisheries (Qld).

Sheep or cattle yards may be adapted to handle goats. Fences to hold goats must be 1.5 m high to prevent them jumping out, as goats are quite capable of jumping fences lower than this when under stress. Holding yards should have water and shade if possible. Shade trees should be located in the corners of the yards and the corners fenced off (if you have ever had to chase a goat around a tree, you will know the reason for this). Holding yards can be constructed of normal fencing materials, but forcing yards should be constructed of galvanised pipe, steel panels made of 2 mm thick box tubing (similar to cattle panels but with closer-spaced bars and only 1.5 m high), or post and steel cable (set very close together). It has been suggested that forcing yards may be constructed of weldmesh or galvanised mesh because they are strong. However, goats can catch their legs – and break them – in this sort of mesh.

If you are not purchasing a commercial goat-handling crush, you will need to construct a working race for drenching and other operations. The race should be high enough to prevent goats jumping out. Unless you are extremely tall, you may not be able to reach over the top of a high-sided race and perform drenching etc. operations. The solution is to build a small raised platform against and parallel to the handling race, to stand on. This allows you to work yet keeps the goats inside the race.

The feeding race leading to the working race, and the working race itself, should be constructed as 'V' races. That is, they should have a V insert at the start so that goats have to enter in single file, preventing them piling up on each other in the races. A V section must be used, rather than just narrowing the bottom sides of the race, to allow for the goats' horns. The bottom of the V race should be approximately 200 mm wide and the top 500–600 mm wide. The V can be constructed of timber or steel, but not mesh, to avoid the possibility of animals getting caught and breaking their legs or ripping their horns off. A working race should be 8–10 m long and divided by sliding gates into two sections. If possible, a roof should be constructed over the working race to provide protection from the weather – two or three hours spent drenching goats while standing in the summer sun can be exhausting. At the end of the working race, a drafting gate should be set up to allow you to draft your goats into various categories such as wethers ready for sale and those that are still to small for sale.

The feeding race should likewise be divided into sections by gates and, if required, these sections can have gates leading into holding yards. Our yards are set up like this and we find it very useful when we wish to isolate an animal that may be injured or that we don't want in the draft. We can trap the goat between gates inside the feeding race and send it into a small holding yard, to be dealt with later.

Goats are drafted through the drafting gate into various holding yards or released back into the paddock. One of the holding yards can lead to a forcing yard and loading ramp. Make sure that the top of the loading ramp is level with the height of the tray of a standard truck, i.e. 1.2 m. If the ramp is the wrong height animals may be injured, falling into the gap between the ramp and truck. They will also be reluctant to enter a truck if they have to jump up or down to the tray. The sides of the loading ramp should be at least 1.5 m high to prevent goats jumping over the top.

3

Choosing your breeding stock

What breeds of goats are best to select for breeding for meat? A major consideration is the requirements of your target market – the export market, the domestic market and stud and commercial breeding stock to supply other breeders for domestic and export markets.

The basic traits required to meet current market demands are size, growth rates and general health.

- Large does will have bigger kids, which are going to reach target weight more quickly.
- Goats should be bred to produce kids with high birth weight and a fast growth rate, so that there is minimal time between birth and marketable size and weight.
- Good health and worm resistance are also important.

When selecting goats it is very important to ensure that they are sound, healthy and not broken-mouthed. The latter indicates that they are too old to be of any use. A goat without a good set of teeth can't feed properly and will therefore not be cost-effective.

Goats have incisors only on their lower jaw, the same as other ruminants. They have a dental pad on the upper jaw at the front, instead of teeth (see Figure 3.1). It is important that the teeth on the lower jaw meet this pad properly and not overshoot it in front or hit at the rear of it. If the teeth don't meet the pad correctly, the animal cannot graze efficiently. This problem is genetic and may be passed on to offspring. Affected kids should be culled.

The first goats acquired are the foundation of your herd and if you have no prior experience with goats it may be a good idea to ask an experienced breeder to help with your selection of stock. You should particularly look at teeth, back, chest, body, scrotum/udder and teats, and age.

- Teeth: the incisors (front teeth) of the lower jaw should meet the dental pad on the top jaw squarely and the bottom jaw should not be overshot (lower jaw is too long) or undershot (lower jaw is too short; see Figures 3.2 and 3.3). Note: Anglo-Nubians sometimes seem to have an undershot top jaw, but on checking you will usually find

Figure 3.1 Normal lower jaw

Figure 3.2 Short lower jaw (brachygnathia), also known as 'parrot mouth'

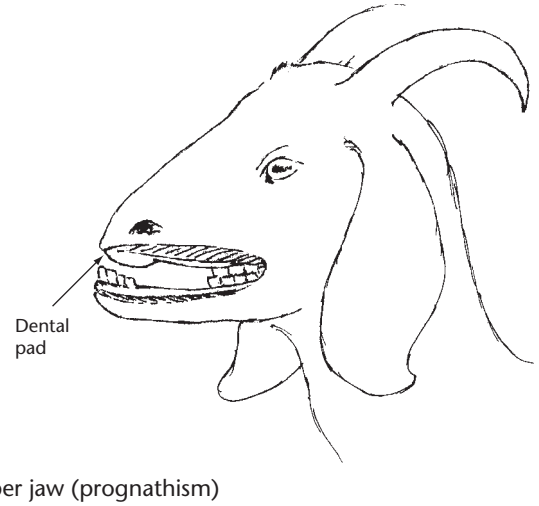

Figure 3.3 Short upper jaw (prognathism)

that the teeth do meet properly and that the illusion is probably caused by a large top lip.
- The back: this should be straight with a small dip just behind the shoulders. This dip is normal for an animal that stands on its hind legs to crop the lower branches of trees and shrubs.
- The chest: this should be deep and its width, between the front legs, should be broad. If you cannot fit your open flat palm on the chest of a goat aged six months or more, its bone structure is too fine. Heavier bone structure gives more area for muscle attachment.
- The body: a doe should have a long body to allow space for developing kids. Having more growth space usually means that kids have a higher birth weight.
- The udder and teats: an udder should have a good attachment and two well-formed teats. The teats must be separate and not blind or joined along their length. If the teats are joined together and give a fishtail-like appearance, kids cannot form the proper vacuum necessary for good suckling. Note: the South African Boer goat is the exception to the two-teat rule – four teats are common and permissible within the breed but, as with other breeds, the teats must be separate.
- Age: check the teeth and ask the vendor how old the goats are. Because each pair of permanent incisors erupts at a different age, we can use their presence or absence to determine the approximate age of an animal. We normally wouldn't buy a doe over four years old.

Choosing a buck

A buck should possess the same characteristics regarding teeth, back and chest, be a good representative of his breed and have the following characteristics.

- A well-attached scrotum, at least 25 cm in circumference at maturity. If you are selecting a very young buck, check scrotal size against that of similar-aged bucks in his group.
- Good libido, in the form of a strong interest in the opposite sex. We have seen a buck kid as young as seven days old trying to mount its sisters. We look for kids like this. Our own experience and that of other breeders shows that in buck kids this behaviour indicates a good libido upon maturity.
- Bucks should have a quiet and tractable nature. If you have ever tried to handle a 120 kg buck in a bad mood, you will understand why. An enraged buck can be dangerous, so any buck that shows aggression toward humans should be culled as soon as possible. An aggressive nature can be genetic and is often passed on to progeny.

Which breeds are best?

For a long time, the three main breeds in Australia were dairy, feral and angora goats. A fourth breed, the South African Boer, introduced in the late 1980s, was the catalyst for a rapid expansion of Australia's goat industry. The South African Boer goat has the size, bodyweight, bone structure and rapidity of growth needed to fulfil all the requirements of the market.

Due to several factors, one of which has been the limited availability of sufficient full-blood South African Boer goats, the Australian meat goat industry has had to use the existing gene pool of the three main breed types. The size, weight and growth rate of these domestic breeds is being increased by using South African Boer bucks over carefully selected domestic does. These does are selected for size, milk production, health, ease of kidding, litter size, mothering ability, availability and affordability.

Dairy goats

Dairy goats have the advantage of larger size and therefore greater bodyweight than the other domestic breeds. This size also means that they usually have multiple births. Twins are usual and triplets and quads are not uncommon. They also produce large quantities of milk, which means that kids will grow more quickly. A kid's growth is affected by two main factors: genetics and the amount of milk available.

The disadvantages of dairy goats are that they are less hardy than feral or Boer goats, have less resistance to worms and are more prone to pregnancy toxaemia, mastitis and milk fever (Hypocalcaemia). Research has shown that there can be a problem in first-cross Boer/dairy ; they can be prone to mastitis due to hybrid vigour. This is believed to be more common in Saanen/Boer crosses due to the genes for high milk production being present in both South African Boer goats and dairy goats. The problem is said to correct itself in the following generations. Finally, dairy goats can also have a problem with coccidia and roundworm infection, as can all goats.

Feral goats

Feral goats have a number of advantages over other domestic goats, and some disadvantages. One advantage is availability. When European settlement began in Australia, many early pioneers brought goats, many of which became feral or were abandoned by their owners. These escaped or abandoned goats included several different breeds, which led to a diverse gene pool and, due to the harsh inland environment where the goats lived, only the fittest and strongest survived. This resulted in a hardy breed that can survive in the toughest conditions.

Goats not only survived in the inland but thrived there and are today present in millions. In the late 1990s there were an estimated 2.6 million feral goats in Australia. This means that there is a readily available and inexpensive supply of both slaughter and breeding stock. The supply is not limitless, though, and due to extensive harvesting to meet the demands of a rapidly expanding export market the numbers of feral goats are decreasing.

On-farm breeding programs are being implemented throughout Australia to meet the demands of the growing export and domestic markets.

Feral goats are smaller than dairy goats and therefore produce fewer kids per litter. They usually have twin or single births. Their milk supply is less than that of dairy goats and production drops quickly 6–8 weeks after kidding. In most feral does it usually stops within three months. This is probably an adaptation to generations of living in harsh inland conditions with limited feed, as is their smaller stature and litter numbers.

Feral goats are less likely to suffer from pregnancy toxaemia or milk fever than are dairy goats, partly due to fewer and smaller kids per litter, a lesser milk supply and the lower birth

weight of the kids. Feral goat kids are likely to grow much more slowly than dairy goat kids or South African Boer kids.

Feral goats appear to have greater resistance to disease than do other breeds of goats, but there have been large losses among feral goats newly introduced to coastal areas with summer rainfall have been found to have a low resistance to Barbers Pole worm, *Haemonchus contortus*, which cannot live in the dry inland conditions. Barbers Pole worm burdens in goats peak in summer, after rain, in the moist warm conditions that the worm needs to hatch. This will not be a problem if proper quarantine procedures are followed when introducing new stock onto your property. This applies to all breeds, not only to feral goats.

If you decide to use feral goats as your foundation herd there are several places from where you can obtain information about a source of does, for example stock and station agents or exporters, trade papers, livestock journals and primary industry or agricultural department extension officers (see Appendix 1). If there are feral goats on your property, you can construct trapyards for them.

Angora goats

Most markets do not consider angora goats to be suitable for the meat trade. In general, the market requires low-fat, easily de-haired animals with firm flesh. Angoras do not meet these requirements. Some markets will buy a few but the prices are not usually as good, as goat price is based on carcass weight, skin-on or skin-off. Because angora goats cannot be de-haired, they must be skinned and the price paid for them is the weight per kilogram, after skinning. The skin comprises 10–15% of the total carcass weight, which can mean a substantial loss of revenue to the producer. This doesn't apply if the goats are purchased on-farm, live weight. However, purchasers know that the goats need to be skinned and will factor this into the purchase price.

There is a good seasonal market, notably in Western Australia, for cull kids which a breeder does not wish to retain, for example kids that are surplus to requirements or that may not carry correct fleece characteristics. Markets for these kids have grown steadily since the early 1990s and there is now a good domestic and export market for 'capretto', the name under which kid meat is marketed.

South African Boer goats

South African Boer goats were introduced into Australia in the late 1980s. The quarantine period lasted about six years and they were released in 1993–95.

To increase the national herd of South African Boer goats more rapidly, artificial insemination (AI) and embryo transplant were employed. Recipient does, including angoras, were used. The South African Boer does were super-ovulated, their eggs harvested and implanted into other breeds of goats using embryo transplant technology.

As mentioned above, South African Boer goats have a number of advantages over other breeds for the purposes of meat production. A full-grown buck can weigh up to 130 kg and a doe may weigh 90 kg or more. They have massive bone structure, which allows plenty of area for attaching muscle and their muscle to bone ratio is impressive. The dressing percentage of other types of goats is probably less than 45%, but the South African Boer

goat will dress out at 50–57%. The difference in dressing percentage is due to the breed's larger muscle:bone ratio.

South African Boer goats usually have twins, triplets or even quads; maiden does may have a single birth, especially if they are joined before they have are 18 months old. South African Boer goats, like other dairy goats, have a good milk supply and lactation can last for many months.

The kids are usually of a good weight when born and average 3.5+ kg, depending on their dam's nutrition during pregnancy and the litter size. Their growth is rapid and it is not unusual for them to double their birth weight in their first month of life. This growth rate is sustained for six months, after which it levels off and becomes more in line with that of other breeds. In general, at any age South African Boer goats are heavier than other breeds.

The does show good mothering ability and are not known to reject their kids. In the case of triplets or quads, the smallest and weakest kid will sometimes be unable to get sufficient milk and may need supplementary feeding because even though the doe has a good supply of milk, the weakest kid may be pushed aside by the stronger siblings. This is not a problem unique to South African Boer goats, as it is common in all breeds of goats with litters of triplets or quads. In a large commercial herd many breeders destroy the fourth kid, as 'time is money'. If the kid is valuable, however, it would be worthwhile bottle-feeding it or attempting to foster it to another doe. Further information on this appears in Chapter 5.

South African Boer bucks are known for their quiet temperament, due to careful selective breeding by the Boers (farmers) of South Africa over many years. Any buck showing aggression should be culled, as should any exhibiting excessive timidity. Why should you cull a buck kid which is very timid? Because a frightened animal is a dangerous animal. When least expected, a very timid buck might decide that attack is the best form of defence and a fully grown buck, often weighing more than 120 kg, can be quite formidable. It is better to cull a timid kid before the problem develops.

Kalahari Red goats

This is a handsome breed that resembles South African Boer goats in form but is red in colour, which is said to help conceal it from predators in the field.

Kalahari Red goats have longer legs, selected for in breeding, to help them cover the distances needed to obtain sufficient feed in the arid environment of Africa. They are also reputed to be more tolerant of drier conditions than many other breeds, including South African Boer goats. When fully grown, Kalahari Reds are slightly lighter in bodyweight than South African Boers, and are reputed to be very hardy and to have a tractable temperament. The breed also makes an excellent cross with Australian feral goats. The main problem with Kalahari Reds is a lack of breeding stock, as there are currently few in Australia. If you are able to obtain stock, semen or embryos of this breed, they are definitely worth using.

Boer/feral crosses

The Department of Primary Industries & Fisheries, Queensland, undertook a two-year in-depth study that compared the production performances of Boer/feral (BF) crosses and

straight feral (FF) goats in semi-arid zones. The project evaluated the reproductive performance of feral does as well as the growth, carcass and economic performance of the offspring in the mulga rangelands of south-west Queensland. At the time of writing, the department was the only organisation in Australia to scientifically examine the performance of these goat breeds in semi-arid pastoral conditions where summer rainfall is dominant.

The study, focused on the harvesting and domestication of feral goats for meat, found that the BF progeny had higher growth rates and the reproductive performance of feral does in terms of kids marked were higher in two of the three years. The growth rate for the 1998 and 1999 drop of BF crosses was 41 g/day and 44 g/day respectively; in 1998 and 1999 drops the FF progeny grew at 38 g/day and 39 g/day respectively.

When slaughtered, the two groups showed no difference in the dressing percentage or fat depth. Across the two years, the average dressing percentage was 40.5% for the BF cross. The BF cross showed a higher average hot carcass weight – 14.6 kg, compared to 12.85 kg for the FF.

In both years the BF progeny were heavier than the FF progeny and, as expected, the males had a higher growth rate and were heavier than the females (Dept of Primary Industries & Fisheries 2002).

Acquiring your first goats

Once you have decided what type of goat-breeding enterprise you would like to pursue, it is advisable to enquire about reputable breeders or suppliers of your chosen breed. The various breed societies can usually supply the names of registered breeders within their industry. Many industry journals and rural newspapers advertise goats for sale or an enquiry at local stock and station agent's offices can also be good place to begin. A call might be all that is needed to find a source of stock. Local goat breeders' groups are usually happy to offer information on where to source goats.

Most local goat breeders' groups were formed by goat breeders for sharing information on the husbandry and marketing of goats, in an informal setting. As members of such a group, we have learned a lot from other breeders and the social contact with people sharing similar interests is enjoyable too. Quite a few people attend several meetings before they even buy their first goats. Attending group meetings such as this can help avoid some costly mistakes involving time and money, due to the sharing of information and experiences between group members.

How to assess goats before purchase

When you arrive at the property or saleyards to purchase goats, it is a good idea to just stand for a few minutes and observe them. This will allow you to note if any appear to be under par. This may include limping, a depressed appearance, harsh or rough-looking coats, scouring or deformities etc. If a number of goats are limping, find out why. It could be simply that they were run on very soft country and their hooves need trimming because they are overgrown. Or it could mean that they have footrot or some other disease. In this case, don't purchase them. The producer, desperate for a sale, might tell you that you can have them cheap. Don't be fooled – dealing with footrot is not cheap. It is expensive and

time-consuming and once the organism which causes it is introduced to your property you will probably never eliminate it.

Harsh or rough coats can be due to high parasite burdens or a protein, vitamin or mineral deficiency. Sometimes these deficiencies are caused by drought.

If you have any doubts, question the producer. Asking costs nothing, but a diseased or sick animal could end up costing much more than you bargained for. Remember – there are other people selling goats and you don't have to buy the first goats you see. Shop around.

After you have watched the goats for a few minutes to ascertain that they appear to be healthy, it is time for a hands-on examination.

- Check the teeth of each goat to ascertain its age and to ensure that it has no deformities of the jaw or teeth and that it is not broken-mouthed (see Figure 9.1). Make sure that the jaw is not overshot or undershot and that it meets the dental pad properly. A goat has two sets of teeth during its life: the milk teeth, which may not all be erupted at birth, and its permanent (adult) teeth. The milk teeth are replaced progressively from the centre by the permanent teeth. By 27–32 months, goats have a 'full mouth' and eight permanent teeth. After this age teeth start to wear down; when they are worn down, broken or fallen out, a goat is termed 'broken-mouthed'. Avoid purchasing these.
- Run your hands over the goat. Are the ribs prominent? If they are, is it because the goat has been on poor feed or has parasites or is it something more serious, such as disease? If you have any doubts, reject the animal.
- Make sure that the goat meets the other basic requirements of conformation and size.

Stock movement information and legal requirements

Before buying stock, ascertain the Johne's disease zoning status in the area and on the property from where you intend to purchase your goats, and in the area to which you intend moving them. All states and territories have regulations regarding movement of stock within, from and to different zones. For example, the Department of Primary Industries, Water & Environment (Tas.) advises that when moving goats from mainland Tasmania (BJD Residual Zone) to Flinders Island (BJD Protected Zone) the goats would have to be from 'MN1 herds' and, at the time of writing, need a permit from the Chief Veterinary Officer. Another thing that must be checked is tick zoning, as there are restrictions in many areas on moving stock from a tick-infested zone to a tick-free zone. In some states, the stock must be dipped before and after crossing the border.

It is imperative that you check the legal requirements for moving stock. Contact your local stock inspector, agricultural or primary industries department, quarantine inspection service or veterinary officer for information on the relevant regulations. They will be able to help you obtain the necessary stock travel permits and tell you how and where to obtain any health certificates needed. This should be done well in advance of the expected date of transport, as they may take a little time to arrange.

An NVD (National Vendor Declaration) Waybill or its equivalent will be required before moving goats. The NVD Waybill is a form detailing the date of movement, the origin of stock, their brands and earmarks, the owner, the destination (for example, a slaughteryard

or another property) and any chemicals or medications that have been administered. Whatever the stock's destination, they will still need an NVD Waybill. NVD Waybills are obtainable from Meat & Livestock Australia, and should be provided by the vendor. A word of advice: make sure that if a waybill is required in your state or territory, you have it before moving the goats. The penalties for moving livestock without one can be very severe, including hefty fines and confiscation of equipment and stock.

We always take blank waybills with us in case the vendor has forgotten to obtain one. Some states and territories, for example the Northern Territory, also require a health certificate.

In New South Wales, Queensland and Western Australia travel documents must accompany livestock movements, and producers in those states have previously had to provide an NVD and a Waybill or Travelling Stock Statement. However, the NVD Waybill have been revised to include stock movement questions, so only one form will be required (except in the Northern Territory, where the NVD Waybill is not recognised as a legal document for stock movements). Producers in other states do not need to fill in this section unless the customer requests it (Palmer 2002)

Western Australia requires identification of livestock under its Stock (Identification and Movement) Act 1970. This identification requirement applies to goats. The requirement was implemented to aid in the recovery of stolen stock and to assist in tracing the origins of any disease. An excellent farmnote (Farmnote 13/1999, amended January 2003) produced by the Department of Agriculture (WA) is available on request, and details the requirements for registering an earmark or brand.

Other states provide information on their identification requirements through their agricultural or primary industry departments. Tasmania has no identification requirement because, under current Tasmanian legislation, branding or earmarking of goats is not compulsory because the Tasmanian goat industry is still quite small so it hasn't been considered necessary to make formal identification compulsory. However, goat producers in Tasmania can apply to the Registrar of Brands to register brands and earmarks, as provided by the Animal (Brands Movement) Act 1984.

Transporting goats

Before the newly acquired goats are loaded onto the transport they should be drenched with a broad-spectrum drench such as albendazole (we like to see the vendor drench them in front of us) and, if they are to going to be on the truck for more than two hours, offered water before loading. If they are going to be travelling for a great distance or to the abattoir, electrolytes should be added to the water to minimise moisture loss. Good commercial products are available from feed stores.

Ensure that goats on the transport are not so crowded that if one falls down it cannot get up again. Many goats are lost in this manner due to being trampled or suffocated. If the truck is carrying a large number of goats, it is a good idea to ensure that it is partitioned into several sections so that the stock don't all squash up together. Decks on a large truck should be partitioned into three or four sections. If the truck transporting your stock isn't, ask the

transport company to do it. It has been known for a truck without partitioning to arrive at its destination with 200 goats piled up against the front of the deck, many of them dead or severely injured.

Quarantine and handling of newly arrived goats

When the goats arrive at your property and are unloaded into their quarantine paddock from the transport, they should immediately be given access to water. They should never be given concentrates such as grain or hay before they have had a chance to have a good drink, because they can become seriously dehydrated during transport and may collapse and die if not adequately rehydrated before being fed. **Goats may experience up to 20% moisture loss during transport**.

Your new goats should be drenched, after you have taken faecal samples to send to your Department of Primary Industries or Agriculture laboratory to have a parasite check done. Vaccinate them if necessary and check them again for disease, injury, parasites or physical deformities.

The new goats should never be released straight into your main herd but should be kept in a relatively small holding paddock where they can be easily observed for 3–4 weeks. The paddock should be well away from other stock and have adequate feed and water.

If they are feral goats directly from the inland and are going to be in paddocks with electric fencing upon release, the holding paddock should also be set up as an electric fence training paddock. The training fences can be set up as full electric fences with nine strands, a maximum distance of 5 m between posts and a dropper between posts. The voltage on the fence should be higher than 5000 volts. The training fence for feral goats must be more secure than the fence required for goats born and bred on-farm, and after a few encounters with the fence even the feral goats will avoid it.

The quarantine period

There are several reasons for a confinement and quarantine period. One reason is that goats can suffer stress or injury during travel and need to be monitored carefully and treated if necessary. Another important reason for isolating new stock is that they may be carrying disease or parasites, many of which have an average incubation period of 3–4 weeks. These diseases or parasites may not be previously present on your property and you obviously wouldn't want them spread all over your paddocks.

Ten days after they have been drenched and while your new goats are still in the quarantine paddock, have another faecal egg count and fluke test done to ascertain their parasite status. This second test should show whether any parasites have resisted the initial drench. If the goats still have a high faecal egg count, try a drench with a different chemical base and keep the goats confined until they have a clear result. The laboratory report usually includes advice on drenching etc. (see Chapter 10 for more information).

Each state has slightly different procedures for parasite tests. Primary Industries Departments will inform you of their test requirements.

The faecal samples should be collected 10 days after drenching with an ordinary broad-spectrum (BZ or white) drench from the benzimidazole group such as albendazole. This

drench is one of those approved for use with goats. Staff from the Wormbuster Lab at the Department of Primary Industries & Fisheries (Qld) advised that the 10-day waiting period for collection of faecal samples also applies after use of other drenches, including those for liver fluke. It is believed that any eggs showing after 10 days will be from worms or flukes acquired on-farm not from their place of origin. If goats are carrying a large number of eggs 10 days after drenching, it could mean that those parasites are resistant to that drench. It has recently been noted that in some areas of Australia there is apparent resistance to two of the macrocyclic lactone group: ivermectin and moxidectin. Drench resistance is discussed further in Chapter 10. Research on this problem is currently being done by the Department of Primary Industries & Fisheries (Qld) and others.

Do not use off-label drenches (not registered for use in goats). Chemical residues in meat and goat products could lead to an entire shipment of exported product being condemned, resulting in a massive financial loss to the exporter **and** the producer, should the product be traced back to them.

It is important to pay attention to the worm burden carried by newly purchased goats, especially those from the inland. If feral goats from the inland are held in paddocks with a high parasite burden, they will rapidly succumb to infestation as they have little resistance to intestinal parasites. This low resistance is due to several factors:

- there are fewer parasites in the dry inland environment;
- there is little grass cover and goats feed mainly on browse (trees and shrubs) which is well above the level of any parasites;
- feral goats constantly move from place to place, so the level of parasites from any one area never has a chance to build up.

Due to this low resistance to intestinal parasites, one new owner of a shipment of feral goats from inland Queensland lost approximately 300 out of a shipment of 700 to Barbers Pole worm, *Haemonchus contortus*, within the first few months of their arrival on the coast.

We strongly recommend that you drench your new stock again 24 hours before they are released into your main paddocks.

Identify and record the new stock before release

Before you release your new stock into the main herd, they should have some identification. Stud stock are tattooed, but if they are out in the paddock the tattoo can't be read so they should also be given an eartag. Non-stud stock need have only an eartag.

In Western Australia, for example, goats must be branded and may be earmarked. Goat owners must obtain a registered brand and/or registered earmark. The registered brand can be in the form of a firebrand on the horn, an ear tattoo or an eartag displaying the registered brand. The registered earmark must be placed in the left ear for female goats and the right for males. All goats in the South-west Land Division must be branded before weaning or six months of age, whichever event occurs first.

There are a number of other regulations and requirements for identification of goats in Western Australia and a full explanation of the procedure and requirements can be found in Farmnote 13/99, Dept of Agriculture (WA).

Earmarks

Earmarks act similarly to a brand in that they make establishing ownership and origin of stock much easier because they are unique to each property. The earmarking is done using a set of earmarking pliers that snip a small shaped piece from the edge of the goats' ear.

After you are allocated an earmark you apply to a brand-maker, who will need a copy of the certificate with your earmark or brand before making your unique earmarking pliers. The local Registrar of Brands will supply a list of brand-makers who can make your pliers and/or horn brands to specifications. Some goat breeders in Queensland and New South Wales have begun to use earmarks even though they are not currently a legal requirement. Stealing goats and changing their eartags would be fairly simple, but earmarks can't be removed – a shipment of goats arriving at an abattoir minus their ears would be very noticeable!

It is important that stock is readily identifiable. It is easier to record that 'Y001' is lame than 'the brown goat with the white patch on her left leg' is lame. As herd numbers increase you may have 50 goats fitting that second description but you will only have one goat with the number Y001.

There are many tagging systems. Manufacturers' catalogues can usually be obtained from local rural suppliers or by mail order.

After a good deal of experimentation, we now use the largest available sheeptag. This tag has numerals 2 cm high that can be seen from several metres away, which is useful when drafting stock in the yards. We know of one breeder who sent the wrong doe to the abattoir because he relied on visual identification of stock. It is a good idea to replace lost tags as soon as you can. It is easy after a few weeks to not know which goat is which, especially if two goats which look identical but don't have the same dam lose their tags within a week or two of each other: we believe that we know which is which, but are we really sure? If the first lost tag was replaced as soon as its loss was noticed, the problem wouldn't have arisen. The large tags look enormous on newborn kids but they soon grow in to them.

We have found that loop-type tags are less than successful in country that contains a lot of shrubby growth. These tags, available in plastic or brass, often catch on branches and twigs. We have seen goats where the tag has ripped completely through the ear and split it in half: this is not only painful for the goat but it makes retagging the animal very difficult.

The loop-type tags are also quite small and difficult to read from further than 2 m. They would be acceptable in some country, such as fully cleared land with improved pasture, but the problem of their small size would remain. However, small plastic loop-type tags are inexpensive and, if there are a number of goats to be tagged, you can make quite a saving compared to the price of large sheeptags.

When you release your goats into the main paddocks, the new goats will have to socialise into the existing herd. Like poultry, goats need to establish a pecking order and for a while there will be much head-butting and jostling. Some goats will actually be bleeding from the horn area and it may be necessary to spray the worst bumps and bruises with Betadine or similar. Have no fear, they will soon sort themselves out and settle down.

4

Breeding season

The importance of record-keeping

If you are going to breed goats as a commercial enterprise rather than just a few goats for your own consumption, then you will need to set up a herd recording system. A good record-keeping system is essential for several reasons:

- recording the identification and registration of an animal;
- improving the average birth to market-weight growth rate by genetic selection;
- keeping a check on dams and sires to prevent inbreeding. Studies on direct inbreeding show that only about one in nine offspring from such matings show any genetic gain. In most cases there is no gain; in our own experience, matings such as these have shown very poor results. We have had a few accidental matings from bucks getting into a paddock with a sister or their mother and the resulting kids have had to be culled as they were very poor types. In a direct mating between father and daughter or mother and son, any genetic faults in the line will be carried 16-fold, not 4-fold;
- recording mating dates and details;
- recording the birth, death and purchase or sale date of an animal;
- recording the offspring of a doe and sire.

There are several systems that can be set up to do all of the above and more. The simplest is the file-card system. This is only suitable for smaller herds; once herd numbers exceed 100 it is probably best to purchase a good commercial software program. This will allow you to keep accurate herd records with a minimum of fuss.

Increasing goat numbers through breeding can be achieved using any of several different methods:

1 natural mating, either paddock or controlled;
2 artificial insemination;
3 embryo transplant.

Well before the breeding season you will need to work out which bucks and does should be joined. We make a joining list for each buck, including all the does that will be joined with that particular buck for the current season. Your list should contain the following columns:

1 tag number;
2 doe's age (optional);
3 doe's dam;
4 doe's sire;
5 joining date;
6 estimated date of kidding (approximately 150 days from the date of joining);
7 comments (for example, did not want to stand).

Matings are chosen to enhance certain desirable genetic characteristics such as size, muscling, conformation and growth rate. If this is the first breeding season you have supervised, you will probably spend many hours going through your lists. Experience is the best teacher and you will soon learn by carefully documenting your results. Good record-keeping is very important. It makes checking details months or even years later so much easier.

A buck may be a magnificent-looking animal that has won several blue ribbons, but his genes may not be heritable. Be ruthless: if a particular buck has sired kids that are very poor compared to the kids of other bucks in your herd, especially if they exhibit cull faults such as undershot jaw, it is better to cull the buck before he passes on his genes to any more progeny. If he sires only one or two poor kids the problems could be coming from the does' lines, but if it is more than a few the buck really must be culled. Ideally, he should be sent to the abattoir, as it is not good for the industry to pass inferior genes to other herds by selling the buck to another breeder. It won't do much for your reputation as a breeder, either, if you sell a poor-performing buck to another breeder. If his kids are below average, cull them too.

Kidplan

An excellent system, called Kidplan, has been launched by Meat & Livestock Australia for the Boer and meat goat industry. The plan was developed following the outstanding success of Lambplan, developed for Australia's sheep industry. Kidplan is a database with records of over 5300 purebred [sic] Boer goats (as at August 2000).

The quality of sires and dams can be identified by using herd data collected by the producer and technicians between birth and adulthood. The following is an extract and outline of the plan, reproduced with the permission of Meat & Livestock Australia. Further details may be obtained from Meat & Livestock Australia or the Boer Goat Breeders Association of Australia.

Why Boer goats?

Boer goats have demonstrated growth rates and carcass traits superior to those of feral goats. Together with fertility and resistance to disease, these traits have a marked impact on

Table 4.1 Comparing individual performance

Animal		Weight at 100 days	Likely genetic value for weight
Group average 31 kg			
990015	35 kg	4 kg above average	Better genes than average for growth
990231	27 kg	4 kg below average	Poorer genes than average for growth

profitability and all can be improved through genetic selection. Kidplan is developing structural traits for mouth, pastern, hocks, shoulder angle and body length specifically for the Boer goat breed.

Using EBVs to identify better genetics when selecting sires

The key points involved in producing simple descriptions of an animal's estimated breeding value (EBV) are:

- measured information – from the animal itself for the desired trait, from other related traits and from relatives;
- adjusting for non-genetic environmental influences;
- accounting for the degree of inheritance.

Measured information

Three pieces of information are used to assess the value of an animal's genes: the animal's own performance for a particular trait, its performance for genetically related traits, and its relatives' performance for those traits.

Animal's own performance

An animal's performance is the result of its genes and its interaction with the environment. Performance of an individual animal can be measured using scales (bodyweight, fleece weight), equipment such as ultrasound (eye-muscle depth, fat depth) or breeder's observation (number of offspring born, structural soundness).

Table 4.1 compares the performance of two individuals. Animal 990015 has a weight that is greater than average. Animal 990231 has a weight that is less than average. It is important to remember that animals are compared with others that have been run in the same environment.

Genetically related traits

In many cases, one set of genes affects more than one trait. Measuring or observing a second trait can provide additional information about the desired trait. The relationship between two traits that are influenced by a common set of genes is known as a genetic correlation.

Table 4.2 shows that eye-muscle depth and fat depth (both at constant weight) are positively correlated – the same genes affect both traits and they increase or decrease them both together. In animal 990015, the fat depth is higher than average and as this positively correlates with eye-muscle depth it is likely that its genes for eye-muscle depth are better for eye-muscle depth (EMD) than that measured.

Where the genes have opposite effects on two traits the relationship is known as a negative genetic correlation. An example is milk yield and percentage of fat and protein in milk (in sheep, goats and dairy cows). Cows with higher milk yield tend to have poorer genes for percentage of fat and protein in the milk.

Table 4.2 Positive correlations

Animal	EMD	Fat depth		Likely genetic value for EMD
		Group average 3 mm		
990015	31 mm	3.5 mm	Above average	Better genes for EMD
990231	31 mm	2.5 mm	Below average	Poorer genes for EMD

Table 4.3 Performance of relatives

Animal	EMD	Family mean EMD		Likely genetic value for EMD
990015	31 mm	35 mm	Above average	Better genes for EMD
990231	31 mm	25 mm	Below average	Poorer genes for EMD
		Group mean EMD 30 mm		

Performance of relatives

Related animals share some common genes. Measuring relatives of an individual means effectively looking at more samples of the genes that they have in common. Information from related animals increases your knowledge about the value of an individual animal. For example, half-sibs (animals with a common sire) on average share 25% of their genes, so if you keep records of half-sibs that gives you further information about the first animal's genes.

Knowing the genetic relationship (pedigree) of individuals and their measured relatives is important. Lambplan and Kidplan have their own information, full-pedigree and at least 10 half-sibs with records. It is important to remember that 36% of the information of an EBV comes from the animal's own record, 10% from its sire, 15% from its dam and 39% from its half-sibs. The information on how its relatives are performing leads to greater accuracy.

Environmental effects

No matter what trait is desired, there are factors other than the animal's genes that influence the level of performance. The effect of non-genetic environmental factors on animal performance means that using a simple measure of performance alone will not give an accurate guide to genetic merit. To make the guide as accurate as possible, environmental factors have to be taken into account.

Easily identified environmental effects include birth date, age of dam, birth type and rearing type, weaning group and management groups post-weaning. Remember to include other effects such as disease problems or feeding differences.

Table 4.4 Breakdown of EBV information (%)

No. records on animal	No. half-sibs with record	No. progeny with record	% emphasis from					Accuracy of EBV (%)
			Animal	Sire	Dam	Half-sibs	Progeny	
0	0	0	0	50	50	0	0	36
1	0	0	56	22	22	0	0	57
1	10	0	36	10	15	39	0	60
1	50	0	25	3	11	61	0	64
1	10	5	10	5	3	32	49	76
1	10	10	8	5	3	27	57	79
1	10	50	4	2	1	12	80	88

Table 4.5 Comparing twins with single births

Animal	Birth type	Weight	Average for birth type	Performance adjusted for birth type
990015	Twin	31	Twins = 26 kg	Own record = +1 kg For being a twin = + 4 kg Adjusted record = + 1 + 4 = + 5 kg
990231	Single	31	Singles – 31 kg	Own record = +1 kg For being a single = –1 kg Adjusted record = +1 + –1= 0 kg
Overall average = 30 kg				

A simple example is that twins tend to be smaller on average than single-born lambs, not because they have poorer genes for growth or bodyweight but because they have had to share nutrition pre- and post-birth. Their environment has not on average been as good as that experienced by single lambs. Another example is that progeny born to maiden breeding females on average have a poorer environment than progeny born to females with more than one parity (pregnancy and birth).

How Lambplan accounts for twins versus singles is shown in Table 4.5. Both animals have a recorded performance of 31 kg. Animal 990015 has been identified as a twin. Twins on average weigh 26 kg (4 kg less than the average of 30 kg), so add 4 kg to its performance. It weighs 31 kg so is still a kilogram better than the population average, so add a kilogram to its performance. The overall merit for animal 990015 is +5. In contrast, 990231, born a single, is average for singles. Singles are 1 kg greater than the overall mean, so subtract 1 kg. The performance of 990231 is 1 kg better than the overall group mean and hence it has an adjusted record of 0.

The aim is to work out how the animals would have performed if they had all had exactly the same environment, had been born on the same day, all been singles, and so on. This means that the animals are compared within groups as if they had exactly the same environment. The above example show that 990015 was 5 kg better than the group and 990231 was average relative to the group with which they were compared. It is also important that known environmental effects are documented and supplied with the animal's performance. Known environmental effects include disease, parasite challenge or physical injury.

Heritability

Even after taking environmental effects into account, not all the differences identified are passed on to progeny. Environmental effects such as birth type can easily be adjusted for, but there are many other environmental effects that can't be worked out so easily, so we do this by using a scaling figure called heritability, which adjusts for all environmental effects not otherwise adjusted for. This accounts for the fact that only a proportion of the observed superiority or inferiority of an animal (after adjustment for non-genetic defects) is actually passed on to progeny. The degree to which differences are passed on (inherited) is known as the heritability of a trait. The heritability of desired traits must be considered when making sound genetic estimations of breeding values.

Typical heritability of performance traits is about 30% for weight and growth, 33–35% for fat depth, 30–40% for eye-muscle depth and about 10% for reproductive traits.

Table 4.6 shows how real differences (adjusted for all factors previously discussed) in live weight are converted to EBVs. Live weight has a heritability of 30% so it can be

Table 4.6 Adjusting differences in live weight for EBV

Live weight difference	Calculation	Live weight EBV
10 kg above average	30% of +10 kg	+3.0kg
15 kg below average	30% of –15 kg	–4.5kg

predicted that progeny of the two animals will inherit 30% of the difference in their observed performance.

An EBV reveals the value of each animal's genes for breeding, but only half that value will be passed on to the progeny. For example, the animal with the highest EBV for growth will pass on +1.5 kg, the other will pass on –2.25 kg. The difference in weight of progeny from these sires will be 3.75 kg.

Putting it all together

The process of producing estimated breeding values is standard. The same set of rules is always followed, the only differences being the adjustments applied to different breeds for different ages of measurement, and in the heritability of different traits.

The bottom line

EBVs give livestock producers a simple description of the potential value of a breeding animal for each trait. Accurate performance records, visual trait assessments and pedigree are needed to develop accurate EBVs (Meat & Livestock Australia 2003.)

Mating age

Young does on our property are not mated before 15 months of age, as our experience shows that they usually have only one kid per birth if mated before this age and often continue to have only one kid per pregnancy thereafter. A young doe is still growing at this age and pregnancy is a tremendous strain even on an adult doe. Because of the strain placed on the system of a very young doe (under 12 months) by pregnancy, she may never reach her full size potential: usually, the smaller the doe, the smaller the kids and therefore the longer the time taken for them to reach market weight.

Young bucks will be able to do a limited amount of work from five or six months but we don't use bucks before they are nine months old. From this age, in their first season they will usually service 12–15 does quite comfortably within the six-week breeding period.

Preparation for breeding

Before bucks and does are joined they must be in breeding condition, and breeders must do some preparation before does are joined. An animal in breeding condition should be well-covered but not fat and it should be obviously healthy and vigorous. The coat should be glossy; a coat that is harsh, is curled at the ends and feels like a scrubbing-brush indicates a health problem. Poor coat condition can be caused by protein deficiency (sometimes due to a high parasite burden such as worms) or a vitamin or mineral deficiency. The cause should be found and eliminated before breeding because it will affect the fertility of the doe, her health and that of her kids.

Good husbandry practice is the way to keep your animals in a healthy vigorous condition so that they are ready to be joined at the start of the breeding season. Good husbandry practices simply means ensuring good nutrition, a low internal and external burden of parasites and attention to their general care, such as vaccination and hoof-trimming. When hooves are overgrown, goats eventually experience pain and discomfort and can't walk far enough to obtain adequate feed for their needs.

The following preparation should be done before joining your does and bucks.

1 Vaccinate for leptospirosis if the condition is known to exist in your area.
2 Drench the herd if necessary.
3 Trim their hooves if needed (some goats never need their feet trimmed).
4 Ensure that all goats to be joined are in good condition.

The natural breeding cycle of goats in Australia begins in autumn as the day length begins to shorten. Most breeders join (mate) their bucks and does between the beginning of March and the end of April, but optimum mating time depends greatly on the weather conditions that will prevail during kidding. If your area experiences cold wet winters or very heavy frosts and you join your does very early in the breeding season, you may suffer substantial kid losses. We had such an unfortunate experience when we first began breeding goats. Our kids began to drop in July and the herd was caught in a storm with heavy rains, which resulted in all the kids becoming saturated. Though we dried them as well as we could, we still lost approximately 20% due to chilling down. The lesson was a hard one. Now, because we know that such weather is common in our area in July, we mate our does late enough that kids won't start to drop before mid-August.

Flushing

Flushing means increasing the level of feed offered to breeding does (see Chapter 7), mostly energy, starting one month prior to joining to increase bodyweight, ovulation rate and expected litter rate. Increasing the level of energy should continue throughout the breeding season and for approximately 30–40 days after removing the bucks, for adequate implantation of the foetuses in the uterus. Body condition determines whether flushing will be of benefit to breeding does.

Does already in extremely good body condition tend not to respond to flushing. Does that are in relatively poor condition as a result of summer pastures of poor quality, high worm burdens or late kidding of twins or triplets, will respond favourably to flushing and their body condition will improve.

Flushing can be accomplished simply by moving breeding does to a lush nutritious pasture three or four weeks prior to the introduction of the bucks. Another method is feeding approximately 225 g daily of a high-energy supplement. Corn is the grain of choice for flushing; whole cottonseed is another low-cost and high-energy supplement. As the goal is to increase intake and bodyweight, breeding does should be grouped according to their body condition and fed accordingly to first improve their body condition and then to maintain it (Luginbuhl and Poore 1992).

At the beginning of the breeding season, bucks will emit a strong characteristic odour which once smelt is never forgotten. Most people think that the bucks' smell is objectionable but does consider it an aphrodisiac and it will soon bring them into heat

(proestrus and oestrus). The smell has two causes: bucks release pheromones from musk glands located just behind their horns, which they rub on every available surface. They are not sharpening their horns, as many people think. The second reason is that they liberally spray themselves with urine, mainly on the rear of their front legs. They spray almost everywhere else too – we have had many dousings! Rubbing on lemon leaves helps to remove the odour.

Bucks also spend a lot of time roaring, day and night, during the breeding season. Sometimes after the first two or three weeks a buck will have no voice left, but don't call the vet. It's only a mild case of vocal cord strain and the buck's voice will return a few weeks after the breeding season. If you have more than one buck they will try to out-shout each other, so it is a good idea to site the bucks' paddock well away from your sleeping quarters.

Oestrus cycle

Towards the end of February, sometimes sooner, does begin to tailwag and mount each other. This indicates the beginning of the fertile (oestrus) cycle, which averages 21 days and has four separate phases:

1 proestrus – the time of follicle growth;
2 oestrus – oestrogen levels rise and the doe ovulates;
3 metestrus – corpus luteum formed to produce progesterone;
4 diestrus – if an ovum is fertilised, the corpus luteum persists to sustain pregnancy for the entire gestation period of 150 days. If fertilisation did not occur, the corpus luteum gradually ceases production of progesterone and the cycle begins again.

When the doe is in the first phase of heat (season), known as proestrus, she will begin to tailwag and sometimes call and may have a vaginal discharge and swollen vulva, but she will not stand for the buck.

In the second phase, known as oestrus, the doe will stand and allow the buck to mount her. He will sniff the doe's nether regions and normally exhibit the Flehmen reaction, which involves curling back his top lip, raising his head and gazing around with a reflective look on his face. This reaction occurs in hoofed animals responding to the smell of female urine. The buck will then stand alongside the doe and snort and strike her on the flanks, using his foreleg. If the doe is not ready for him, she will move away. If she stays still, the buck typically makes two or three not very serious attempts at mounting her, possibly to see if she is ready to stand for him. If the doe stands, he will then mount her. Often, if he has done the job correctly, after he dismounts you will see the doe tuck her tail and rear end tightly underneath her body for 20 seconds or so: this is the equivalent of the human orgasm. The period of oestrus lasts for 30–40 hours and varies considerably between does. Approximately 30–36 hours after oestrus begins the doe will ovulate, but this is also variable.

During the third phase of the cycle, metestrus, the doe will no longer stand for the buck and is said to have gone out of heat.

At this time the corpus luteum is formed. It produces the hormone progesterone. If an ovum has been fertilised, this hormone prevents any more follicles being formed and prepares the uterus to receive the fertilised egg or eggs (Haenlein 1992a).

If the doe is not pregnant, approximately 21 days after the first signs of proestrus she will cycle again (come back into heat). In maiden does and sometimes in older does, the first cycle of the season will be a sterile non-ovulatory one. These does may cycle again seven days later or may take a full 21 days before coming back into heat. Does normally ovulate during the second cycle and will become pregnant when joined with the buck or artificially inseminated.

Natural mating

There are several methods of natural mating, each of which can be useful in different situations. We have used all of them at different times, equally successfully.

Paddock mating

There are four different methods of carrying out paddock mating.

1 letting the stud buck run with the herd year-round;
2 putting the buck in at the beginning of the natural breeding cycle, i.e. autumn;
3 allowing multiple bucks to run with the does, either year-round or only during breeding season;
4 using controlled individual mating, which is traditional with dairy goats.

The first method may seem like less work at first glance, as you need not be concerned about when to introduce and remove the buck and it is not necessary to keep him in a paddock away from the does. A buck paddock which can keep a buck away from cycling does needs to be very secure. A buck is very powerful and, when he has the scent of a cycling doe, a very determined animal indeed. If fences are not securely constructed you can look forward to a lot of work repairing them, and a number of unplanned pregnancies.

The advantages of allowing one or more bucks to continually run with the does may be outweighed by the disadvantages. If bucks are running with does year-round, you will need to remove their daughters and any young maiden does (which may become pregnant as young as five months of age) and run them as a separate herd. Second, the kidding season is not confined to six to eight weeks but continues almost the entire year. However, there is a period in early spring when does do not seem to cycle. Extended kidding makes marking (castrating), vaccinating, backlining for lice and drenching (dosing for parasites) constant jobs. If the kids are born within a six- to eight-week time frame, all these tasks can be carried out at approximately the same time.

The second method of paddock mating involves putting the buck or bucks in with the does during autumn, usually from early March, to run together for six to eight weeks. The usual ratio is 40–50 does for each buck, although this varies according to individual capacity. We have a buck that will cope with 60–70 does in the breeding period, without a problem. Last season only two does did not become pregnant.

The nutrition level of bucks is an important factor in both their potency and libido, so pay careful attention to this. Bucks often need extra rations during breeding season and often lose quite a lot of weight because they are more interested in courting and mating than in eating. They soon regain condition once they are removed at the end of the breeding season.

The disadvantage of running bucks with the does only during the breeding season is that, as discussed previously, they have to be confined very securely when not actually working and, unless the paddock in which they are confined has good feed, they will need supplementary feeding to maintain condition. This can be expensive unless you can produce your own feed. The advantages of keeping bucks locked away from the does outside breeding season are:

- all does and wethers can be run in one herd except for the actual period when the bucks are running with the does;
- kidding and the work associated with it is confined to a limited time frame;
- handling does and wethers is easier when you don't have to contend with bucks in the middle of the herd.

Controlled mating

Also called individual mating, controlled mating is mainly used in the following circumstances:

- when providing service for a doe from another producer;
- when a doe with exceptional genetic traits refuses to stand for a particular buck. Sometimes you may wish to join a buck to a particular doe for genetic gain, but she may not like the buck. This doesn't occur often, but it does happen;
- if a doe cycles out of season or very late and you decide that you wish to join her.

Our property has several small isolation pens for goats that are injured or ill, for does that need to be bonded to kids after refusing them (usually very young first-time mothers) and for individual or hand mating. The procedure is fairly simple. Observe the doe's behaviour to make sure she is cycling and ready to stand. During proestrus, before the period of oestrus begins, you will notice other does and wethers trying to mount her but she will not stand. When she is coming into oestrus, she will stand and allow other does and wethers to mount her. The best time to observe this is early morning before the goats begin grazing or late in the afternoon before they begin to settle for the night.

Readiness for joining

The doe will be ready to be joined 12–15 hours after she begins to stand; she usually has a vaginal discharge and the vulva will be swollen. These signs are more obvious in some does than others. The lifespan of an egg is 12–24 hours and that of a sperm 24–48 hours, so don't panic if you have been a little premature in joining the doe. We have found that the doe will usually become pregnant from the mating.

It has been observed that South African Boer goats are not as seasonally polyestrus as many other breeds of goats and can often be mated quite successfully out of season. Angora goats are the opposite of this and are seasonally polyestrus.

When the doe is ready, put her into the isolation pen or headbail then introduce the buck. If it is a service for another breeder or an out-of-season mating, the doe may be quite willing to stand for the buck and you will not need to hold or headbail her. In this case, just let the buck do his duty. However, if she is not willing to accept him you may have to hold her head to prevent her moving away. We usually permit the buck to mount her at least

twice during half an hour, which is normally sufficient to do the job. When offering service from your buck to another breeder, it is usual to offer a return service at no extra cost if the doe or does do not become pregnant on the first service. If you are joining full-blood South African bucks and does, it is usual to give a Certificate of Service to the owner of the doe being serviced; indeed, without it the offspring cannot be registered with the Boer Goat Breeders Association of Australia.

We have created our own Certificate of Service, as shown in the box. The does, their owners and the addresses are fictitious.

Certificate of Service

Dam	**Registration or Tag**	**Breed**	**Owner**
Katy	ZZZFV539	FB SA Boer	A. & A. Smith, Smiths Way
Sally	ZZZFV2807	FB SA Boer	The Black Stump
Sire	**Registration or Tag**	**Breed**	**Owner**
Big boy	BCVFT 99999	FB SA Boer	B Vincent

[your address here]

Period of Joining
From: 03 05 2000 **To:** 08 05 2000

Mode: Paddock

BARBARA VINCENT
Flock Master
Claravale Park Boer Goat Stud
[Insert signature here] [date]

If you allow another breeder to bring does or bucks onto your property for joining, ensure that the goats are disease-free and parasite-free. Check them from head to foot. Insist that the owner drench them before they come and check their vaccination and CRV status (caprine retrovirus; see Chapter 9). Examine their feet for footrot and their coats for lice etc.; also note their general appearance. If you have any doubts, refuse service. It's too late once you have a diseased or parasite-infested visiting buck or doe who may share their problem with your stock; better to forgo one service fee than spend years eradicating an introduced pest or disease. In the worst scenario, it could mean the end of your enterprise.

Artificial insemination

Why use AI?

- AI is a useful tool for improving your herd by introducing genetics from superior bucks that may not be available in any other way.

- Most superior bucks producing sperm for AI have been progeny-tested for conformation, weight gain, fertility and temperament, unlike most on-farm bucks.
- Because you do not need to keep your own bucks if you use only AI for breeding, the problem of keeping bucks segregated from closely related or very young does is eliminated.
- The considerable cost of feeding and housing a buck, that is non-productive for much of the year, is eliminated if you use AI and don't keep your own bucks.
- The danger of transmission of parasites or disease is greatly reduced (Haenlein 1992a).
- A number of does can be inseminated on the same day when synchronisation of oestrus is practised (Smith 1992b).
- AI allows the breeder to know exactly when the doe was bred and therefore when to expect kidding.
- By using AI a goat can be made to kid out of normal breeding season and a market thus supplied that would not be if kidding occurred in August or September. Kids that are dropped in early spring are often too small for marketing during the peak export period, which is from June to late September, or early October on the east coast.

Artificial insemination can be done by a veterinarian, by a qualified technician or by yourself if you have undertaken the training. AI courses run from time to time so find out when the next course will be held in your area.

In a stud or a commercial enterprise, the costs involved in carrying out AI can be considerable and they should be carefully examined before undertaking such a program. The set-up costs include purchase of a liquid-nitrogen storage tank for storing the straws of semen, and the straws themselves. The tank will preserve the straws of semen at –196°C.

There are two methods of carrying out AI: the vaginal technique and the laparoscopic technique.

Vaginal AI

If you are going to be doing the artificial inseminating yourself using the vaginal technique, you will need the following:

- speculum – pyrex (22 × 175 mm for maiden does and 25 × 200 mm for adult does), stainless steel human vaginal speculum or plastic disposables;
- lubricating jelly (KY);
- thawing box;
- inseminating gun for straws;
- paper towels;
- a means of securing the doe, such as headbail, rope or fence;
- notebook for recording breeding dates, buck's name etc.;
- gloves;
- scissors to cut straws.

The major cost involved is the semen storage tank, varying from approximately $1100 for a 1000–1400 straw tank to $2100 for a tank of 5000–6000 straw capacity. Members of various goat producers' groups could jointly purchase a tank, greatly reducing their

individual costs. Tank space could be rented to members for storage of semen, further defraying the purchase cost and the cost of recharging the tank with liquid nitrogen every two to four months (liquid nitrogen evaporates). It may be possible to purchase a second-hand tank. The other pieces of equipment will cost about $250–300. Most breeders will find that the smaller tank is adequate: the price of straws is usually a limiting factor, as they cost $20+ each and are often sold in lots of 10 or more.

The costs of vaginal AI are possibly lower than the cost of keeping your own bucks when all factors are taken into consideration.

We will not describe in detail the procedure for vaginal AI as it must be carried out only by people who have been fully trained in the technique. An untrained operator who performs the procedure incorrectly could perforate the doe's uterus or vagina, and kill it. To give an idea of what is involved, a short explanation of vaginal AI follows.

When the doe is in heat and ready to stand (usually 12–24 hours after she shows signs of cycling, or 12–36 hours after removal of a vaginal sponge – see below) she will be ready for AI. A clean and dust-free area is essential for the procedure, and all equipment must be assembled before beginning. The doe should be immobilised in a headbail or tied to a fence or post. A speculum is inserted into her vulva and the straw containing the thawed semen is introduced into her cervix, using the special applicator designed for the job. The contents of the straw are then expelled into the uterus. Remember: proper training is essential.

Laparoscopic insemination

In Australia, the laparoscopic technique of insemination must be carried out by qualified veterinary surgeons. It has a higher success rate than does vaginal AI. The preparation is time-consuming and fairly expensive but if the semen you wish to use is valuable or difficult to obtain, for example from a champion buck, the procedure is definitely worth considering.

Several assistants are needed during the procedure but volunteers are usually easy to find, as most breeders are interested in seeing how it is done.

Recipient does should have already had and raised at least one kid. The best recipient does are angoras or domesticated feral cashmere does; dairy does are not suitable recipients.

Oestrus synchronisation for laparoscopic AI

The does to be used in the laparoscopic AI program must be synchronised to bring them into simultaneous oestrus. This allows insemination of does that are normally very difficult to detect in heat (silent heat). Techniques of synchronisation are varied; the simplest is introducing a buck or his odour (the buck effect) early in autumn. Many of the does will come into oestrus 8–10 days later.

A teaser buck (infertile male) can be introduced first and replaced three weeks later with a fertile buck. Reasonably good synchronisation will be achieved on the second cycle. If does are already cycling, the synchronisation effect will largely be lost (Smith 1992b).

Synchronisation is usually achieved, however, using a combination of several different hormones; your operator will provide full instructions. It will involve the vaginal insertion of sponges or controlled internal drug release dispensers (CIDRs), followed by a course of hormone injections for both the donor and recipient does. Your vet or the company carrying out the insemination will tell you exactly what is required to prepare the does.

Synchronisation of donor and recipient

In Australia, France and elsewhere, synchronisation of does is commonly achieved by the use of intravaginal sponges impregnated with 45 mg of fluorogestone acetate. Sponges with less hormone (marketed for sheep) give a lower conception rate. The sponge is coated with an antiseptic or an antibiotic powder or ointment (Savlon® ointment is commonly used) and is pushed deep into the vagina, by finger, and left there for 17–21 days. The string designed to aid sponge removal must be cut short unless each goat is housed separately. When the sponge is removed it will be covered with a purulent exudate, but this exudate does not interfere with conception and no further treatment is necessary.

Hormone injections

Hormone injections are used to stimulate follicular development after the sponge is removed. Recipient does require only one treatment, involving the injection of gonadotrophins and prostaglandins. Donor does receive injections morning and night for four days, involving three hormones: FSH (follicle-stimulating hormone), prostaglandins and progesterone. **Pregnant women should not handle these hormones**.

The does generally come into heat 12–36 hours after sponge removal and are bred within 48 hours. Some companies prefer that the does be mounted only once, then removed from the buck. The program supervisor will advise you about this.

Lights

Natural oestrus is controlled by day length. Goats are seasonally polyestrus and exhibit cyclic heats during autumn under the influence of decreasing day length. After the winter solstice, the average goat enters a period of anestrus. The physiological differences between the autumn breeding season and the anestrus season necessitate the use of different techniques for control of oestrus during each period.

An alternative to synchronising oestrus using hormones or the buck effect is by keeping the does under lights. The does are kept under long 'days' of 16–20 hours for several months then returned to ambient day length; many will exhibit fertile cycles in the next few months. Cycles will not be exactly synchronised with this technique and not all does will cycle (Smith 1992b).

This technique requires the goats be shedded every night. A timer switch can be installed to automatically activate lighting as soon as the light level starts to fall each evening. It is a fairly hit-and-miss technique and is less reliable than synchronisation using hormones.

Does used in the program must be in top condition prior to beginning the synchronisation procedure. The company doing the procedure will usually advise on the diet needed and whether vitamin injections should be given. A course of B12 is often recommended, because Australian pastures are frequently low in cobalt.

Embryo transplant

An embryo transplant or transfer (ET) program is a very useful way to introduce new genetic lines into your herd at a reasonable cost. It also allows the importation of embryos from countries such as South Africa and the US, into Australia. This importation expands

the local gene pool to give a wider base for breeding programs to upgrade the quality of Australia's national goat herd.

Due to problems with diseases such as foot and mouth, the importation of embryos may be temporarily halted sometimes; even when it is permitted, precautions are taken to ensure that the embryos are disease-free. Imported embryos have been washed up to 10 times to remove any material adhering to them, which could carry disease. South Africa was closed for export of embryos for a time due to the presence of foot and mouth disease, and embryos collected in South Africa between 1 August 2000 and 31 May 2002 are ineligible for export.

There are many restrictions and regulations on the importation of genetic material from overseas, all subject to change at any time due to outbreaks of disease in various countries. The Australian Quarantine and Inspection Service and other authorities such as the Australian Customs Service must be consulted when you are considering importing semen or embryos from other countries.

Preparation of does for embryo transplant

Preparation of does for embryo transplant is the same as that required before undertaking laparoscopic insemination. The does must be brought into top condition in the weeks prior to beginning the program, using similar but more intense preparations than those carried out before the natural joining of bucks and does. The does should be placed on a high-energy diet; some embryo transplant teams suggest including lupins. The amount of lupins should be gradually increased, to a daily ration of 300 g per doe. White lupin is a very high-protein feed so do not give the full amount immediately – it can cause severe digestive upsets. Like any new feed it must be introduced slowly to give the goats' rumen time to adjust. You will thus avoid the problems of bloat, scouring and enterotoxaemia.

Make sure that all does being fed concentrates have access to good-quality hay or pasture. When feeding high levels of concentrates it is necessary to provide enough feed bulk for good ruminal scratch and so avoid the problems of bloat and acidoses caused by high-grain diets with insufficient roughage.

Preparing the operating area

The does will undertake a program of oestrus synchronisation carried out by you following instructions from your embryo transplant team. You will also need to make the following preparations for carrying out the transfer.

1. The transplant team will need a clean sheltered area in which to carry out the embryo transfer procedure. Most properties have a shed that can be used for this. You will need to clear a good working space, free of tools and machinery, sweep it clean and hose the area to remove as much dust, hay and other organic materials (such as manure) as possible. Any foreign material entering the incision during the operation can cause major infection.
2. A race adjacent to the shed, in which to keep the recipient does, will be needed. Once an embryo has been thawed there is a very short time during which it is viable and may be transferred successfully to the recipient doe. Speed is of the essence in the operation.

3 You will also need a recovery area alongside the shed where the unconscious does can be taken to recover after the transfer has been completed.

The procedure

1 Take does off feed and water 24 hours before the procedure to prevent post-operative bloating.
2 When a doe is brought into the work area an assistant straddles her and holds her by the horns (or the head, if she is dehorned), and pulls her head up slightly and to the right side. The technician or vet then injects an anaesthetic such as pentothal into a vein on her neck. Within 20–30 seconds the doe is unconscious and ready to load into the laparotomy (surgical) cradle, which holds her throughout the operation. The goat is loaded into the laparotomy cradle while it is horizontal. The cradle will later be raised to an almost upright position for the procedure itself, so that the intestines can be reflected away from the reproductive organs during the operation.
3 When the doe has been loaded into the laparotomy cradle her lower abdomen is shaved, dusted to remove any loose hair and sprayed with an antiseptic. She is then given oxygen to make sure that she will not suffer oxygen deficiency during the operation (her inverted position in the cradle during the transfer procedure puts pressure on the heart and lungs and makes it more difficult to receive enough oxygen).
4 The cradle is raised to the upright position (approximately 80°), the shaved area on the abdomen is draped and the operator begins the procedure. While the operator is making the incision the assistant, who is usually a qualified technician, will be defrosting the embryos to be used for that doe and checking to make certain that they have divided correctly and are not damaged.
5 The embryos will have been checked prior to freezing to make sure that they have divided to at least the 120+ cell stage, at which time they are classed as blastocyst embryos. Two embryos are implanted into the doe's fallopian tube. The incision is sutured then sprayed with an antiseptic such as Cetrimide and the doe is given an injection of a long-acting antibiotic. She is then removed from the laparoscopic cradle and taken to the recovery area.
6 In the recovery area the doe is placed in the recovery position – upright, with her head on her flank and one front leg turned back on the opposite side to her head. Does must be watched to make sure that they do not fall onto their side while they are still unconscious, as this may lead to suffocation.

After about an hour the does should be recovered enough to be returned to their paddock. If the weather is rainy or very cold and windy, the paddock should have some shelter. Don't worry if does are a little depressed and less lively than usual as this will only last for a few days, after which they should be back to normal.

Pregnancy

Pregnancy testing

Sometimes it may be important for a producer to know whether does are pregnant. Veterinary surgeons will do pregnancy testing, usually via ultrasound. There are two

methods of ultrasound: the vaginal method and the exterior abdominal method. Some vets believe that the exterior abdominal method of ultrasound is less likely to cause abortion than the vaginal ultrasound. The exterior abdominal ultrasound resembles that used by gynaecologists for human females. The vet can also usually tell how many foetuses the doe is carrying; this is information that can be useful in an embryo transplant program.

Gestation period

The nutrition and care of pregnant does is very important. If a doe lacks any of the necessary nutrients such as carbohydrates, protein, vitamins and minerals then the growth of the kids in utero will suffer. Unborn kids put on 80% of their growth during the last few weeks of pregnancy. The minimum crude protein requirement of does of in the final six weeks of pregnancy is 8% CP daily but in cold weather this requirement increases. If does are in their final few weeks towards the end of winter, pastures are often low in protein and you must supplement with a good source of protein such as specially formulated and balanced goat feed pellets, goat mash, cracked corn or barley.

Kids whose dams (mothers) are short on adequate levels of protein, carbohydrate, vitamins and minerals do not grow properly and will have low birth weights and slow post-natal growth; some types of deficiencies such as low iodine or selenium levels may cause foetuses to abort, or die soon after birth.

The does should be on a rising plane of nutrition during the latter part of their pregnancy and, if there is little feed in the paddocks due to drought or the feed is of poor quality because of low protein levels in winter, supplementary feeding is usually necessary during the final six weeks. In our experience, an initial supplement of 125 g of cracked corn, crushed barley or commercial goat ration pellets, built up to a maximum ration of 200–250 g daily, is usually sufficient to bring them into kidding in good condition. We have found that 300 g of goat feed pellets, formulated by our feed supplier at 16.5% protein, brings the does into excellent condition for kidding and lactation. We sometimes add a good-quality grassy lucerne hay (barley hay is good but sometimes hard to obtain) to their ration, depending upon what feed is available. A feed nutritionist once said, 'The best and most economical feed is that obtainable in the paddock'. This is true when there is no drought, but in a drought there is usually not enough feed, or quality feed, available to sustain the doe and foetuses in a state of good nutrition. A general loss of condition in the herd, assuming that they do not have a heavy worm burden, disease or cobalt deficiency for instance, usually means that nutritional needs are no longer being met and you may have to consider hand-feeding even earlier than the recommended six weeks before kidding.

Continually check the condition of pregnant does. Ten minutes each evening watching them as they go to their night camp lets you notice a change in the general condition of the herd and that of any individual. For instance, you will see the signs of pregnancy toxaemia (discussed in Chapter 9) early enough to initiate treatment before matters get too serious. A doe that actually collapses from pregnancy toxaemia can die even if treated, so the earlier the condition is noticed, the better.

The does to watch for are the ones trailing at the back of the herd. If you notice any doe not keeping up with the rest of the herd, it is time to take a closer look at her. She may simply need drenching for worms, but never assume that worms are the sole cause – examine her properly. A healthy pregnant doe should gain weight steadily, have a good coat

which doesn't feel harsh (like a scrubbing-brush), a nice clean skin that is not dry or flaky, and her gums and the inside of the lower eyelids should be a good healthy pink.

Undernourished does and those carrying multiple foetuses may develop pregnancy toxaemia, also known as twin-kidding disease. The demands of the growing kids can be too much for a doe's system and she may develop a severe energy deficit due to inadequate carbohydrate from insufficient feed in the paddock. Under-exercised and overweight does, confined in small yards, may also develop pregnancy toxaemia. In our experience, the sick doe begins to look depressed, she may limp, her lower legs can be swollen from fluid accumulation and she may lose substantial weight. If the condition is not treated promptly, by correcting the energy deficit, you may lose the doe.

Breeders should read Chapter 9's discussion of metabolic diseases, to become familiar with the symptoms of these conditions. Metabolic diseases are reasonably common in most livestock, particularly in drought years, because of poor nutrient levels in feed or simply lack of feed.

Does should be denied access to dolomite during the final six weeks of pregnancy because they need to mobilise calcium from their bones; if they do not do so because their bloodstream already contains high calcium levels, the does may develop hypocalcaemia after delivery. This condition is also known as milk fever (treatment and condition are discussed in Chapter 9).

Your first kids will begin to drop approximately 150 days from the date of joining. Goats, however, are individuals and vary slightly in gestation periods both within and between breeds. Our experience has shown that feral cashmere goats have an average gestation period of 147 days, a little less than other types of goats.

Table 4.7 is a useful guide for estimating kidding dates, assuming a gestation period of 150 days. For example, a doe joined on 1 January has an estimated date of kidding (EDOK) of 30 May.

Six weeks before the does are due to begin kidding, you must start preparing. Preparations include the does themselves and the area where they are to drop their kids.

Preparing the does for kidding

1. The pregnant does will need to be drenched using a simple broad-spectrum drench. If white drenches (benzimidazoles) still work in your area this would probably be the drench of choice. Don't use drenches containing closantel close to kidding, because they can cause does to abort. If you are unsure which drench is safe to use, ask your vet or Department of Primary Industries extension officer for advice.
2. Trim any overgrown hooves, before the final six weeks. The stress of restraint and handling may cause does in the final stages of pregnancy to abort their foetuses.
   Backline them for lice if necessary.
   Give a B12 injection if necessary.
   Assess the condition of the does by checking coat, gums and condition score (whether you can feel their ribs). They should ideally be in condition score 2–3.
3. Give a booster vaccination, either a 3-in-1 or 6-in-1 vaccine. The conditions most likely to be precipitated by kidding are tetanus and enterotoxaemia (pulpy kidney).

The 3-in-1 vaccine covers the main diseases likely to be encountered both during and immediately after kidding and there is less chance of a reaction such as a cold abscess

Table 4.7 Estimated date of kidding

Date joined	EDOK	Date joined	EDOK	Date joined	EDOK	Date joined	EDOK
Jan 01	May 30	Apr 02	Aug 28	Jul 01	Nov 26	Sep29	Feb 24
03	Jun 01	04	30	03	28	Oct 01	26
05	05	06	Sep 01	05	30	03	28
07	07	08	03	07	Dec 02	05	Mar 02
09	09	10	05	09	04	07	04
11	11	12	07	11	06	09	06
13	13	14	09	13	08	11	08
15	15	16	11	15	10	13	10
17	17	18	13	17	12	15	12
19	19	20	15	19	14	17	14
21	21	22	17	21	16	19	16
23	23	24	19	23	18	21	18
25	25	26	21	25	20	23	20
27	27	28	23	27	22	25	22
29	29	30	25	29	24	27	24
31	Jul 01	May 02	27	31	26	29	26
Feb 02	03	04	29	Aug 02	28	31	28
04	05	06	Oct 01	04	30	Nov 02	30
06	07	08	03	06	Jan 01	04	Apr 02
08	09	10	05	08	03	06	04
10	11	12	07	10	05	08	06
12	13	14	09	12	07	10	08
14	15	16	11	14	09	12	10
16	16	18	13	16	11	14	12
18	17	20	15	18	13	16	14
20	19	22	17	20	15	18	16
22	21	24	19	22	17	20	18
24	23	26	21	24	19	22	20
26	25	28	23	26	21	24	22
28	27	30	25	28	23	26	24
Mar 02	29	Jun 01	27	30	25	28	26
04	31	03	29	Sep 01	27	30	28
06	Aug 02	05	31	03	29	Dec 02	30
08	04	07	Nov 02	05	31	04	May 02
10	06	09	04	07	Feb 02	06	04
12	08	11	06	09	04	08	06
14	10	13	08	11	06	10	08
16	12	15	10	13	08	12	10
18	14	17	12	15	10	14	12
20	16	19	14	17	12	16	14
22	18	21	16	19	14	18	16
24	20	23	18	21	16	20	18
26	22	25	20	23	18	22	20
28	24	27	22	25	20	24	22
30	26	29	24	27	22	26	24
						30	28

forming at the injection site or, more seriously, an anaphylactic reaction. Some breeds of goat are more sensitive to vaccination than others; for example Saanen dairy goats may react severely to vaccination and die within a few minutes of injection. This is usually in response to a second vaccination, however. The more different antigens in a vaccine, the more chance there is of an adverse reaction, thus 3-in-1 is preferable to 6-in-1.

Preparing the kidding area

The does will need a good clean area for kidding. There must be some shelter for the does and their kids and the area should be within sight of the main house, so that if predators enter it you will have some chance of being alerted in time to protect the kids and does. Some breeders put one or two guardian dogs in with the kidding does, to protect them, but other breeders have had problems with this. In one instance, the guardian dog, a Maremma, was too protective and wouldn't let the does near the kids. The problem was solved by putting that dog in with the wethers and a different dog in with the kidding does.

We have constructed portable shelters for the kids to shelter beneath. These mimic the fallen logs and undergrowth beneath which does park their kids in the wild, to conceal them from predators. They are made of scrap timber and are basically square boxes 60 cm high with sides measuring 150 cm × 150 cm, open in the front and the back. If made of pine or something similar, they are quite easy to move.

The shelters are 60 cm high so that we can crawl underneath them to collect the kids, for instance, to take them back to the pen in the evening. We always check for snakes first, though, as it is quite warm and cosy in the shelter and snakes often crawl in for a sleep! We know someone who came face-to-face with a large and angry black snake when recovering some kids from such a shelter.

If the does are to be kidded out in pens, the floors should be covered in bedding straw. If kids are dropped onto a dirt floor, bacteria can enter the raw end of their umbilical cords and they may develop an infection which is capable of killing them.

A good supply of clean water should be available at all times. If the does are going to be drinking from somewhere other than a dam, for instance from basins or troughs, ensure that the kids cannot fall into these and drown or die of cold. That happened in our kidding area many years ago, when we hadn't realised just how active a newborn kid can be. The kid leapt into the trough, was unable to get out and died of hypothermia.

Equipment and supplies for kidding

The following are some necessary and/or useful items to have on hand for kidding:

- Betadine for the kids' umbilical cords: this is a 'must have';
- cod liver oil in case artificial feeding is needed;
- a packet of cottonwool;
- anti-diarrhoeal mixture, a simple kaolin and pectin type. Tablets or mixtures containing Imodium can paralyse the gut of goats and kill them;
- toilet paper or paper tissues for wiping kids' rears if necessary, in their first few days after birth;
- two lamb feeding bottles (plastic soft-drink bottles can serve in an emergency);
- four lamb teats – kids wear these out fairly quickly. We store them between seasons in a jar containing cornflour and in a dark cupboard, which is quite effective in stopping them from deteriorating;

- eye protection, such as safety glasses – certain diseases such as Q fever can be contracted from amniotic fluid, especially if splashed in your eyes;
- disposable gloves;
- a jar of zinc and castor-oil cream in case of cracked teats – there are several veterinary brands of this inexpensive cream;
- eartags for the new kids – if kids are tagged as soon as they are born there is no hassle with finding the mother of forgotten kids when goats return to the night area each evening.

If you have made good preparation for the kidding season there will be no last-minute panic to get set up.

Abortion

Sometimes a doe will abort her kids. If it is only an isolated incident, don't be alarmed as she may produce a litter next season without any problems. However, if several does begin to abort it is time to take a closer look.

There can be many reasons for abortion, including nutritional deficit, disease, poisoning, or low levels of selenium, iodine, copper or other vitamins and minerals. Unless the cause is known you should seek professional advice. It may seem expensive, but so is losing many kids in the drop.

Some diseases that may cause abortion are leptospirosis, chlamydia, Q fever, toxoplasmosis and listeriosis. These diseases are discussed further in Chapter 9.

Abortions may also be caused by caloric deficiency, protein deficiency and hypoprogesteronism (low progesterone levels). The results and symptoms of caloric deficiency are normal appetite, stillbirth and weight loss; those of protein deficiency are stillbirth, retained placenta and loss of condition; low progesterone levels cause abortion due to insufficient hormone produced by the corpus luteum.

The symptoms of particular deficiencies are listed below.

Vitamin A deficiency leads to:

- abortion;
- night blindness;
- convulsions (no paddling);
- watery discharge from nostrils;
- retained placenta;
- weak kids if they are not aborted;
- oedema of the brisket;
- weight loss.

Iodine deficiency may cause:

- abortion;
- alopecia (baldness);
- weak kids;
- goitre (in dam and kid);
- stillbirth.

Manganese deficiency may cause:

- abortion;
- anestrus (failure to cycle);
- blind kids;
- deformed kids.

Selenium deficiency (white muscle disease) may cause:

- stillbirth;
- arched back;
- dyspnoea (laboured breathing);
- sudden death;
- weak kids.

Poisoning

Nitrate or nitrite poisoning can cause:

- abortion;
- ataxia;
- brown blood (chocolate-coloured);
- breath that smells of ketones (sweetcorn);
- convulsions (no paddling);
- cyanosis;
- hyperaesthesia (hypersensitivity of an organ, including the skin, to touch etc.);
- subnormal temperature;
- rapid pulse.

Selenium poisoning can cause:

- stillbirth;
- alopecia;
- ataxia;
- hoof problems (abnormal growth, distortion, cracking);
- frothy discharge from the nostrils;
- paralysis of the tongue;
- dilation of the pupils;
- running into objects.

Iodine poisoning can cause abortion (Baxandell 1988).

5

Kidding management

If predators are a problem in your area, does should be moved into the kidding paddock for their final six weeks of pregnancy. The kidding paddock should be as near as possible to vermin-proof and close enough to the homestead that you can hear any does in distress while kidding, or panic caused by a predator in the paddock. Most does are considerate enough to kid during daylight hours. Very few kid at night.

Hormonal changes occurring during the last few weeks of pregnancy alter the doe's body in preparation for the birth of her kids.

There are several hormones involved in the process of labour and parturition, including:

- prostaglandins – these augment the myometrial (the muscular outer layer of the uterus) contractility and indirectly cause the withdrawal of progesterone. Prostaglandins are also involved in cervical softening and cause secretion of relaxin from the corpus luteum;
- relaxin – this is released by the corpus luteum as it begins to deteriorate towards the end of gestation. Relaxin acts on connective tissue to allow relaxation of pubic ligaments and softening of the cervix;
- oxytocin – oxytocin has an important role in parturition. It acts on the uterus, causing myometrial contractions and the release of progesterone from the endometrium (lining of the uterus) and the cervical mucosa.

As the due date approaches, a doe will keep more to herself and her vulva will become soft and swollen. When she is lying down or, in the final week of her pregnancy, standing, you may notice that the vulva begins to gape a little. This is a good sign, indicating the ligaments and muscles are responding to relaxin, the hormone that relaxes the pelvic ligaments and permits it to widen to allow the passage of the kids.

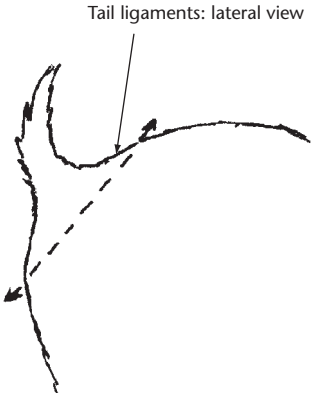

Figure 5.1 Tail ligaments, lateral view

The tail ligaments will begin to soften under the influence of relaxin during the final 24 hours of pregnancy. In a non-pregnant doe, or one in early pregnancy, the ligaments on either side of tail are quite firm and have very little 'give'. When the ligaments begin to feel very soft and spongy labour is imminent and the doe usually delivers within a day. You can feel the tail ligaments by placing your hand on top of her rump, just in front of the tail, with your fingers facing toward the tail. Spread your index and middle fingers so that they rest on either side of the tail; press down gently but firmly (see Figures 5.1 and 5.2). You will feel a ligament on either side of the tail, that feels like a tight rubber-band. This is easy to feel on non-pregnant lightweight does. Once you have practised on a few of those, it is easy to locate these ligaments on does that are very fat or in an advanced state of pregnancy (Umo et al. 1976; Haenlein 1992b).

A doe sometimes exhibits nesting behaviour. She may begin to dig and scrape at the ground with her front feet and will be restless, standing up and lying down in the 'scrape' that she has created.

When a doe is about to begin labour, she moves away from the herd. This withdrawal may serve several purposes.

- The first living animal that kids see is their mother, so they will bond with her rather than another doe. Kids form bonds very quickly: if it is necessary to assist a doe to

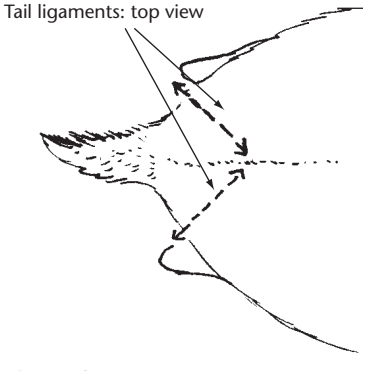

Figure 5.2 Tail ligaments, view from above

deliver, for example, kids may bond to the person assisting at the birth and not to their mother. You should never intervene in a birth unless it is necessary.
- During the time that she is away from the herd with her newborn kids, the doe 'talks' to them constantly and they to her, and each learns to recognise the other's voices. A kid can recognise the sound of its mother's voice in a herd of hundreds of goats and vice versa: we have always been amazed by this.
- Other does sometimes kidnap newborn kids: to prevent this, the kids' mother keeps them away from the herd.

Labour and parturition

Labour and parturition have three stages.

Stage 1 – the uterus undergoes rhythmic contractions and the ligaments, which hold the pelvis together, relax. The connective tissues of the uterus become disorganised (ripening). This leads to cervical compliancy (softening), effacement (thinning) and dilation. At the doe's due date you may notice a clear discharge from her vulva, sometimes including a trace of blood. This is the cervical plug, which is being expelled as the cervix begins to dilate during the first stage of labour. It blocked the entrance to the cervix to prevent any bacteria etc. entering the uterus during gestation. As with human beings, the first stage of labour can take some hours in a first-time mother.

Stage 2 – the amniotic sac ruptures (the waters break). Frequently however, the tips of the hooves and nose of the first kid may be visible yet the sac is still intact. In this stage, the cord is often compressed and the kids' oxygen restricted, so if the doe does not deliver the kid shortly we often rupture the sac and clear the kid's nostrils. Kids can then breathe for several minutes before they are finally expelled, quite safely.

Stage 3 – the placenta is expelled. The placenta is sometimes referred to as the membranes.

Labour begins approximately 150 days after joining and is usually trouble-free. However, if the doe is fully dilated and has been pushing for more than half an hour, or seems distressed, it is a good idea to assess the situation more closely.

If labour is prolonged, the uterus will eventually stop responding to the signal to contract and the birth canal and pelvis can begin to close. A caesarean section is the only thing that will save the kids and their mother if this occurs: to avoid the operation, the doe will need your aid. If there is no vet available you will have to intervene yourself. Don't be afraid to try – this is not hard after a little practice. Remember that in the absence of a vet, you are the only person who can help the doe.

Before beginning an examination, make sure that the doe is on clean grass or, if she is in a pen, on clean bedding straw. The last thing she needs is an infection caught from dirt or dust. You will need a few things to carry out the examination:

- two buckets of warm water;
- disinfectant;
- disposable gloves;
- gynaecological lubricant (KY jelly or similar is fine);
- eye protection (birth fluids and placenta can carry leptospirosis and Q fever);

- Betadine for the kids' cords;
- two snares made from strong 600 mm-long cord, with a noose at each end.

Put on safety glasses to protect your eyes from birth fluids, and a pair of gloves. Lubricate the gloves with a generous amount of lubricant (approximately a tablespoon) and you are ready to begin your examination of the doe and kids and, if necessary, deliver them.

The following text on kidding difficulties, from the Department of Primary Industries (Vic.) (McDonald 1981) is reproduced with the kind permission of the Victorian government. It is a step-by-step guide to the examination and delivery of kids.

Kidding difficulties

When to leave the doe alone, when to help and when to call the vet

Normally, kidding is a 'hands-off' situation with no need for panic or assistance by the owner.

Nevertheless, assistance is necessary if no kids are delivered within half an hour of the doe starting serious straining and breaking of the water bag.

Kidding problems are not common in goats because of the relatively small size of the kids in relation to the diameter of the pelvis of the doe. Nevertheless, some oversized kids occur and there are a number of possible abnormal birth positions due to multiple births and 'legginess' of the kids.

Difficult births are most common in Anglo-Nubians because they are more likely to have triplets or quads, which can get tangled up. Saanen does kidding for the first time may have a big single buck with a large head, which could cause problems.

Responsible and experienced goat owners can assist most does that are having kidding difficulties. Novice breeders or complicated cases may require assistance from a veterinarian. With multiple kids some experience, common sense and patience are generally all that is required. Also, avoid using great force, which will injure or paralyse the doe.

The point at which veterinary assistance is required should be discussed with your local practitioner. Depending on the owner's ability and the location of the farm, some practitioners will provide owners with obstetrical lubricant and pessaries to facilitate manipulation of kids within the uterus. Others will advise against any manipulation past the vagina. In any case, assistance should be sought if no progress is made after manipulation for more than a quarter of an hour. If a caesarean section is required then any further delays will only exhaust the doe further and increase the risk of the vagina and uterus becoming swollen and bruised.

Presentation

There are two normal presentations for a kid at birth. These are:

- front first – when the water bag (a dark round bulge) breaks and is followed by two feet and a nose, does usually labour for 15–45 minutes to deliver the first kid. If all appears well, leave her alone. Many owners like to be involved, but they should not upset the doe and cause unnecessary trouble;
- hind first – when two hind feet and no head follow the water bag. The soles of the feet will face up instead of down. It is generally easier for the doe to give birth to a kid in

this position, without the abrupt bulge of the head. The only problem is that if birth is delayed when the kid is half out, the umbilical cord can be squashed off or broken by the pelvis of the doe so that the kid tries to start breathing while its head is still in the uterus, and it suffocates.

General advice on kidding difficulties

Husbandry

Keep does handy during kidding time to allow frequent inspection, and yarding or shedding at night should assistance be necessary. Usually the doe will give birth unassisted, but you should be prepared for the abnormal delivery.

Keep your fingernails short during the kidding season in case an emergency requires you to assist a birth. Short fingernails lessen the risk of you scratching or tearing the uterine wall.

Preparation of the doe

The first step is to catch the doe and restrain her for examination. If she has been in trouble for some time she will be lying on her side; in this position most does can be assisted with the operator kneeling behind them. Sometimes her hindquarters may need to be elevated to allow a kid to be pushed forward for repositioning, especially if two kids are blocking the birth canal. A bale of hay under the abdomen may assist.

The hindquarters of the doe should be cleaned with antiseptic and the operator's hands and arms should be thoroughly scrubbed and soaked in antiseptic and obstetrical lubricant.

Two buckets of water and disinfectant are often used, one for washing the doe and the other for use by the operator.

Disposable gloves are now also worn.

Obstetrical examination

In goats, as in sheep, the wall of the uterus is thin and tears easily compared with the thicker, tougher uterus of cattle. The uterus and vagina of a goat dry out quickly if assistance is prolonged. Saline douches and plenty of obstetrical lubricant are helpful. Obstetrical lubricant can be purchased or made up by shaking antiseptic and clean paraffin oil together.

The examination commences by seeing or feeling if the neck of the uterus has opened, what part or parts of the kid or kids are coming first, and why – or if – it is stuck. The hand should be slightly cupped, the thumb tucked in between the fingers and inserted through the vulva to feel and assist the kid.

Supplies and drugs

Supplies to have on hand include a couple of snares (strong cord, about 600 mm long and with a noose on each end), a penicillin injection to be given after assisting, or antibiotic uterine pessaries. These will help eliminate infection that is likely to be introduced when manipulation and assistance is given.

Antibiotics are only available from your vet.

Assistance at kidding

When pulling kids, time your pulling to co-ordinate with the doe's straining and labour contractions. Once the kid is coming out, always pull in a downward direction, i.e. towards the udder of the doe. Don't yank or pull suddenly or abruptly on the kid; ease it from side to

side, or up and down slightly, to gradually get it out. Rub lubricant around the kid if it becomes dry.

The most common decision, which has to be made, is whether to feel inside for another kid when the first has been delivered. This presents the danger of introducing infection, and it would be very wise to wash hands and arms again before doing this. If the doe does not continue to strain and the afterbirth comes away easily, no further investigation should be needed. If your hand has already been in the uterus (provided your hand and arm are clean) you can check to see that all kids have been removed.

After the birth, place the kid near the doe's nose to reinforce the mothering instinct, especially if the doe is tired. She will usually lick the kid to get it dry and stimulate better breathing.

If the kid has had a difficult birth and there is 'rattling' breathing, hang it upside down to drain, wipe the mucus out of its mouth and give it a few gentle taps on the sides. In dirty surroundings, disinfection of the navel with iodine is advised.

Abnormal kidding

There are a number of abnormal kid positions. Suggested remedies are as follows.

- Large head or shoulders – tight delivery. Peel the vulva back over the head while easing the head forward, either using a snare around the back of the head (not the neck) and tightening in the mouth, or by grasping the head using a thumb and forefingers in front of the eye sockets. Pull one leg at a time to make more room. If the kid is much too big or the pelvis too small to make any progress, seek assistance.
- Front half out, hips stuck. Gently pull the kid, swinging it from side to side to make it slip out. If this doesn't work, try rotating the kid a quarter-turn while pulling.
- Head-first with one or both legs back. Quite often, gentle pulling will assist birth of a small to normal-sized kid in this position. If no progress is made, check that the legs and head belong to the same kid.

  You may have to push the head back to get space to slip the legs up. Shield the uterus from being torn by the hoof by cupping your hand over the hoof as you draw it up and over the brim of the pelvis. When the head and two front legs are in position, pull the head out. It often helps to attach snares to the head and one or two legs before they are pushed back.

  With a large kid, often only the swollen head is out, and the kid is dead. The head may have to be cut off the kid before the kid is pushed back so the front legs can be found and pulled out.
- Both front legs out, head turned back or down. Identify the front legs (soles facing downwards), slip a noose over each and push them back to allow access to the head. Pull the head forward with your hand or a noose around the back of the head and tightening inside the mouth. Then pull front legs out (by means of the attached cords) and ease the kid out in the correct position.
- Breech first – an 'impossible' birth. The tail may be hanging out but the hind legs are pointed away from the pelvis opening, with the kid coming out backwards. Push the kid's buttocks forward and ease one hind leg at a time up over the brim of the pelvis

in a flexed position, being careful not to tear the uterus with the hoof. Then pull the kid out in the hind-first position.

- Crosswise with both legs pointing away or through the pelvic opening. This will take a bit of figuring out, but again push the kid away and rotate it to allow delivery. If the hind legs are as convenient as the front, choose the hind legs and you won't have to reposition the head.
- Twins coming out together. There are many possibilities. The most common is the hind legs of the second twin coming with the front legs and/or head of the first twin. One twin, usually the one coming backwards, must be pushed back to allow the other twin to move ahead. However, the primary rule is to first deliver the one that requires the least amount of manoeuvring. Take your time and work carefully and slowly, so that you know what you are doing.
- Abnormal births that require veterinary help. In complicated births, where you don't feel competent, work for no longer than 15 minutes before you seek assistance. Such situations may include large kids (requiring a caesarean), dead kids which may be swollen (requiring some dismembering), twisting of the uterus, uterine inertia (labour contractions are weak) and monstrosities or deformed kids.

Other problems related to kidding

These include retained afterbirth, metritis (post-kidding infection) and prolapse.

The placenta is normally passed within one hour of kidding and must be removed within 12 hours of kidding because by then the neck of the womb has mostly closed. Don't try to unbutton the cotyledons (remove the afterbirth) yourself as you may cause excessive bleeding. Usually this is done by a vet using antibiotic cover. Pessaries containing hormones such as stilboestrol should not be used because they can cause agalactia (drying-up of the milk) and nymphomania (constant heat or oestrus).

Metritis or infection of the uterus is common after a difficult birth and retained afterbirth. Normal discharge is thick and dark reddish-brown. It starts a few days after kidding, lasts for 2–3 weeks and clears up without treatment. However, if the discharge is a different colour, is purulent (pus) or smells and the doe is ill (off her feed, feverish, and down in milk production) call the vet.

If you haven't dealt with prolapse of the vagina, cervix or uterus before, the vet must show you what to do. Don't worry – it looks more dramatic than it is.

Immediately after birth

In goats, there is no need to cut the cord because it will separate from the doe within a minute or two of delivery. In rare instances it doesn't; it may then be necessary to sever it with a clean blade or scissors. We usually leave 5 cm attached to the kid. There is no need to tie it off. The cord of all newborn kids should be dipped in buffered iodine or a good antiseptic.

You must dispose of the placenta promptly. Don't leave it around the kidding area because it will attract predators and flies. Some does like to eat their placenta, some do not. It is your choice whether to allow your does to do this. If a doe does not want to eat her

placenta, remove it immediately. The exception to this is if you have a doe that does not want her kids (discussed below).

The doe will usually appreciate a drink of warm water with some molasses and powdered dextrose (glucose) added. We mix 125 mL of molasses and two tablespoons of dextrose powder into 2 L of warm water. Our experience shows that such a drink boosts their energy levels after the long and exhausting job of labour.

If the labour has been long, the kids may also be exhausted and have a subnormal body temperature. If this is not treated, they will die. There are two common methods of treatment – a heatpad or electric blanket (on medium), or bathing the kid in warm water.

Place the heatpad in a large cardboard box or wooden crate and cover it with something to protect it from fluids such as urine. We dry the kid first with an old towel that has not had softener or other highly perfumed products used on it, because perfumes alter the kid's odour which may cause the doe to reject it. Place the kid on the heatpad and cover it up, leaving its head out so that it can breathe and its mother can see and touch it.

The second method, which we have used several times, is a bucket of water heated to about 40°C. Immerse the kid in this up to its neck, for about 20 minutes. You will need to change the water at least once to maintain the temperature. Make sure that the kid does not immerse its head at any time, because if any water gets into its lungs it will develop pneumonia and die.

Either method will raise the kid's core temperature to the required 38°C within 20–30 minutes. Check the temperature using a rectal thermometer. When the temperature has reached the correct level, you can give the kid back to the doe. If you used the warm-water method, before returning the kid make sure that it is dried thoroughly with a clean unperfumed towel, and re-dip its cord in Betadine.

Examine newborn kids for defects

Each kid should be examined for defects when it is born. Some conditions, such as abrachia (absence of both front legs), obviously mean that the kid must be destroyed. Other conditions are less obvious and it is helpful to know what to look for. Table 5.1 lists the more common birth defects and suggested ways of dealing with them.

Drench does

It is important to drench does within 24 hours of kidding, because of the rise in faecal egg counts of Trichostrongyloidea, associated with parturition and lactation. This is called the periparturient rise (PPR) and is triggered by two factors: the periparturient relaxation of immunity, that is in turn associated with the hormonal changes of late pregnancy and lactation. A major hormonal change involves prolactin, the primary lactogenic hormone.

This suspension of parasite-specific immune responsiveness results in incoming larvae (either previously arrested or newly ingested from pasture) developing into egg-laying adults without any immune response from the doe, and the suspension of immunological constraints on egg production by worms already in the doe's body.

The result is a rise in the output of nematode eggs, leading to an increase in faecal nematode egg counts in ewes [sic] in late pregnancy and lactation (Johnstone et al. 1998).

Table 5.1 Birth defects

Problem	Description	Action
Abdominal fissure	Opening in the abdominal wall with herniation of organs.	Destroy
Abrachia	Absence of front legs.	Destroy
Albinism	Lack of pigment, pink eyes: goat prone to vulval, nose and ear cancer due to lack of protection from the sun.	Destroy
Atresia ani	Lack of any anal opening.	Destroy
Beta-mannosidosis	A genetic defect of Anglo-Nubians. Kid has bent limbs which can't be straightened, appears to have cerebral palsy and can't feed unassisted. Defect means that the kid can't eliminate a type of sugar from its cells It is caused by a simple recessive gene – 13% of Anglo-Nubians are carriers. If left, the kid will die in 10 days or so.	Destroy at birth: it will die in a few days anyway
Brachygnathia	Short lower jaw (parrot mouth), teeth hit behind the dental pad. Heritable.	Destroy or use for meat
Cataract	Lens opaque, blind kid.	Destroy
Cleft palate	Fissure in the hard or soft palate (roof of the mouth).	Destroy
Entropion	Eyelids turned inwards.	Treatment, usually successful, is to turn lids out several times a day for a few weeks. Make sure hands are clean when doing this
Hermaphroditism	Internal genitals of both sexes, with intermediate external genitals. This can result from the mating of two naturally polled goats (who carry recessive genes which can cause genetic defects in offspring).	Destroy or use for meat
Penile defects	Abnormally short or crooked penis, or a persistent frenulum (inability to retract penile sheath and allow mating; can also cause stricture and prevent urination).	Wether: use kid for meat later
Prognathism	Short upper jaw. Heritable.	Destroy or use for meat
Scoliosis	Lateral (sidewise) deviation of the spinal column.	Destroy
Scrotal hernia	Intestines protrude into the scrotum.	Destroy
Supernumerary teats	Correct number is breed-dependent: South African Boer goats can have 4 teats, but not other breeds. Heritable.	Do not use for stud
Torticollis	Twisted neck/wry neck, sometimes due to pre-birth position. Wait a few days and see if it corrects itself.	May need to be destroyed if the condition does not correct itself
Wry tail	Defect between coccygeal vertebrae. Heritable.	Not fatal, don't use for stud

This section mentions ewes because it is based on trials carried out on sheep in south-east Pennsylvania, testing the effectiveness of Ivermectin on both the adult and arrested development of the Trichostrongyloidea group of worms.

The ewes lambed between 1 January and 15 February. Six weeks after lambing began, the faecal egg counts of untreated ewes started to rise. The PPR peaked on 29 April, the day

of weaning. At that point, the ewes' faecal egg counts dropped precipitously, reflecting a self-cure of their worm population (Johnstone et al. 1998).

PPR and goats

The PPR also exists in goats but unfortunately they do not appear to develop any immunity to the Trichostrongyles such as Trichostrongylus: Black scour, *Haemonchus contortus* (Barbers Pole), Cooperia, Nematodirus etc. Attempts have been made to select for natural resistance to roundworms in sheep and goats: there has been some success with sheep but little with goats.

We recommend that all does be drenched with a good broad-spectrum drench on the day that they kid, because our experience has shown a sharp rise in faecal egg counts within three weeks of kidding. If the does are not drenched their faecal egg count will not fall, as it does in sheep. It will continue to rise and may even kill the doe. If the doe is carrying threadworm (*Strongyloides papillosus)* the situation can be even more serious, because this species of nematode will pass directly to the kids through the milk. The ova are laid embryonated (with a live embryo inside) and this nematode will rapidly infest the kids. The strain on a doe's body due to lactation is hard enough without the added drain of a high parasite burden, and not drenching can also prove fatal to kids.

The following example illustrates what can happen without a policy of drenching all new mothers. A producer bought an eight-week-old Anglo-Nubian kid from a producer who did not believe in using any chemicals on stock. This included drenches and vaccines. The kid seemed to be depressed and did not want to feed from the bottle, and the owner brought the kid to us very late one night to see if it should go to the vet in the morning. The kid was obviously very ill, had a subnormal body temperature of 35°C, was in pain (grinding its teeth and writhing) and had white gums. Its eyes were sunk back in its head (dehydration) and its coat was harsh and dry. The droppings also seemed very dry. We did a faecal egg count, which showed that the kid was infested with four different types of parasites. The number of each on the slide was so high it was almost impossible to count them. They included tapeworm (*Moniezia*), Coccidia (*Eimeria* sp.), Strongyle species (probably mainly *Haemonchus contortus,* because it was summer) and threadworm. The count for threadworm alone was over 9000 EPG (eggs per gram). The kid died while we were doing the faecal egg count.

A high parasite burden, such as this, is usually due to overstocking. If the stocking rate is too high and there is no paddock rotation or drenching program, pastures become completely infested with parasites (see Chapter 10).

Mothering and mismothering

Most goats are good mothers. A doe will lick her kids clean and, when they manage to clamber to their feet, will nudge them towards her teats (see Figure 5.3) and talk to them while doing so: Anglo-Nubian mothers are particularly vocal. Healthy kids will gain their feet after a short time, usually 30 minutes. They often fall over several times but after a few tries manage to stay upright. They then try to find the teats but usually haven't a clue where they are and will try to suck everywhere, including between their mother's front legs.

Figure 5.3 A young South African Boer doe nudging her newborn kid towards her teats

If the kid is weak due to a difficult birth, you may have to direct it to the teat and even need to support it and place the teat in its mouth, for the first feed or two. You might have to do this for the first few feeds if the kid has had an unusually tough time during delivery. If a kid is extremely weak it may be suffering from hypoglycaemia (low blood sugar) and will require treatment (see Chapter 9). All being well, kids should be snuggled up next to mum within a couple of hours, all enjoying a well-earned rest.

Kids need to have their first feed within 12 hours of birth so that they can receive the full benefits of the antibodies (immunoglobulins) contained in their mother's colostrum – after 12 hours the gut is no longer receptive to them.

The first motion that a kid passes is the meconium. This sticky, black, tarry substance forms a plug in the large intestine before the kid is born. After the kid passes the meconium, the motions will become yellow and are not pelleted, as are the motions of older kids and goats. These first yellow bowel motions are very sticky and clay-like. They can often block the rectum and, in female newborns, the urethra. They can form a hard, concrete-like mass under a kid's tail – if this is not removed, it will kill the kid in a few days. 'Changing the kid's nappy' is not pleasant but must be done. Most does clean under the tails of their kids, but some lack the instinct to do it. The problem is not unusual in young first-time mothers.

To change the kids' nappies, we keep a supply of toilet paper, disposable gloves and plastic bags in our kidding pens. A bucket of warm water is also useful, as it helps to dissolve the caked-on faeces. These are often very solidly attached to the skin and hair around the anus, vulva and rectum. Do not rip faeces off – you may injure the kid. Wear gloves while doing this job because the substance is rather smelly and its odour will persist on your hands for hours, even with repeated washing.

The mass must be softened with the warm water before you start to gently remove it, and you may have to break it into several smaller pieces. Easy does it – we have seen kids bleeding from the bowel due to over-enthusiastic attempts to remove dried faecal material.

We use damp toilet paper to do the final clean-up. Make sure that the toilet paper is not perfumed.

Mismothering

In all species, some mothers will reject their offspring, even attacking and killing them. Goats are no exception. Some does want nothing to do with their kids and will forcibly prevent them from suckling. A doe who has had a very difficult delivery, who is exhausted and perhaps in pain, is more likely to reject her kids than a doe who has had a relatively easy labour and delivery. The problem is more common in young does. A young mother may take one look at her kids and wonder what are these annoying little things that persist in wanting to suck her tender and sore nipples.

If you have a doe that rejects her kids, don't put the kids straight onto the bottle. Bottle-feeding may seem easy at first, but remember that a kid is usually not weaned until it is at least three months of age. Being tied to feeding kids three times a day for three months is very inconvenient and time-consuming; it is also expensive. Bottle-feeding is never as good for kids as their own mother's milk.

If you do not wish to be tied to hand-rearing kids, the doe will have to be taught to accept them. The first thing is to isolate the doe and her kids in a small pen, for example measuring 3×1.5 m, with walls 2 m high. The pen should have its own water supply and hayrack, and bedding straw.

Put on a pair of unperfumed disposable gloves, then take the doe's placenta and rub it all over the kids' backs, faces and rear ends. Rub the placenta on the doe's face, nose and inside her mouth. Be very careful: if you have had to help with the birth, your odour or that of any perfume or aftershave can be transferred to the kids. The doe has a very sensitive sense of smell and can detect foreign odours even when we cannot. After you have carried out this unpleasant but necessary job, you are ready to start training the doe to accept her kids. The following method has always proved successful for us.

Restrain the doe in a headbail or tie her head to a post to prevent her moving away from the kids. A doe that does not want to feed her kids can be as slippery as an eel, so you will also have to prevent her from moving sideways. You may have to show the kids where to find the teat, but most know by instinct how to find it for themselves. You will have to restrain the doe to allow the kids to suckle four times a day for a week, which is usually more than enough time to teach her to accept the kids. It sometimes takes only 24 hours before the doe is happily accepting her new role as a mother and can be released with her kids into the herd of new mums with no further worry.

In the case of a doe that actively rejects her kids, shoving them away or actually headbutting and hurting them, you will need to use another approach. Confine the kids in a small crate where the mother can see them but not make direct physical contact with them. This way she can get used to their sight, sound and smell without being able to harm them: a child's wooden playpen lined with shadecloth to prevent the kids squeezing out between the bars is good for this. At feeding time, restrain the doe as before so that the kids can feed and return them to their crate after each feed. Most does accept their kids after a day or two but one doe took 10 days to do so; she was an exceptional case.

If a doe does the same thing next season, she should be culled. We give a doe the benefit of the doubt – once – if she is young and inexperienced, but a repeat performance sees her heading to the nearest abattoir. As mothering instinct is a heritable trait, we do not sell does with poor mothering instincts to other breeders.

Feeding

A doe may have a fully engorged udder and her kids will be suckling frequently but after a day or so you notice that the kids seem to be very hollow-sided, possibly even hunched and shivering. The problem is often due to blocked teats, only rarely is it due to insufficient milk.

To prevent bacteria travelling up the teat during the last few weeks of pregnancy, a plug of wax-like material (keratin) forms in the duct. Normally the first suckle removes this, which allows the colostrum and then the milk to flow. However, sometimes the plug is too hard and thick or the kid's sucking action not strong enough to remove it, so the kid becomes starved and dehydrated.

You must remove the plug or the kid will die. The plug is not difficult to remove. Wash your hands thoroughly then wash the udder with warm water to remove dust and any debris. Restrain the doe and gently squeeze each teat. You should see a little plug of material at the end, which you can carefully remove with the edge of your nail. In stubborn cases, we use a human breast-pump. This is very effective and we have used the same one for many years. The breast-pump is also useful for obtaining uncontaminated colostrum for storage.

Another feeding problem arises from kids being weak after a difficult birth. They might need help to stand long enough to receive sufficient colostrum. If they are very weak, it may be necessary to give colostrum, and later milk, from a bottle because milk flows faster and easier from a bottle and requires less effort than feeding from the mother. Give kids their own mother's milk if possible.

We usually put kids to their mother's teat first (with support if needed) then finish their feed with the bottle. Most of the time, within a few days they are feeding from their mother without a problem. The bonus of giving them their own mother's colostrum and milk is that they will develop the same smell as their mother, lessening the chance of her rejecting them because they don't smell 'right'.

If a kid is very weak or premature, we give five or six feeds a day for the first two days. At the first feed 50 mL is offered; if the kid takes it all we increase the amount by 25 mL per feed until the kid is obviously satisfied.

If a kid is too weak to suck, we use a feeding tube introduced directly into its stomach through the mouth. Instruction from a vet **must** be received before using this technique because if the tube is accidentally placed into the trachea (windpipe) instead of the oesophagus (food pipe) you will rapidly kill the kid by syringing milk or colostrum into its lungs. Even a little milk in the lungs is enough to cause pneumonia, which will kill within a day or two.

Sometimes a kid is born without any instinct to nurse. This may be caused by brain damage due to anoxia (oxygen deprivation) during birth. We destroy kids with this problem, as they are usually defective and will die soon anyway. The exception is a very premature kid that must be tube-fed – we have found that these usually develop a sucking reflex in a day or two. To test for the sucking reflex, place your little finger about 3 cm into the kid's mouth, making sure that it is in contact with the palate (roof) of the kid's mouth as that will help to initiate the sucking reflex. If the kid can suck, it will usually do so quite strongly. A word of warning: make sure that when you put your finger into the kid's mouth,

you do so from the front and not the side of the mouth. The molars are razor-sharp and can give you a nasty nip!

A kid may suck but unable to achieve a proper vacuum. There are three common causes of this.

- The doe has poorly formed teats – double or fishtail teats, blind teats or teats too large for the kid's mouth. The kid will need to be fostered onto another doe or bottle-fed. Consider culling the doe.
- The kid has a cleft palate and must be destroyed – when the kid attempts to suck, milk will often flow from its nose.
- The kid has a malformed jaw, either overshot or undershot, and must be destroyed.

Some producers keep a kid with a malformed jaw but our policy is 'If it's not perfect, its offspring probably won't be'. A goat that can't feed well won't grow well, and these conditions are often heritable.

Artificial feeding

Infrequently a doe will have no milk, if she has a very traumatic labour or her hormones don't 'kick in' correctly. There are several ways of dealing with this.

- If the doe's milk has not come down within an hour of delivery, call the vet. The vet will be able to give the doe an injection of oxytocin, which acts rapidly to bring the milk down. This must be done as soon as possible because kids' guts are receptive to the antibodies in colostrum for only about 12 hours.
- If another doe lost her kids around the same time as the problem doe kidded, matters are not too serious because, with a slight adaptation of the method used for mismothered kids, you can get the bereaved doe to accept the starving kids. Use the 'isolation and playpen' method and within a week the foster mum will accept the kids of the other doe. This is a lot less time-consuming and cheaper than bottle-feeding.
- If you don't have a handy foster mother, you will have to bottle-feed the kids. There are good products available but they are expensive. They come in powder form and are available from vets and feed stores. If you follow the instructions on make-up and feeding, you can't go too far wrong. Care must be taken to ensure that all feeding bottles are scrupulously clean, to prevent bacterial infection that can cause scours.

Note: do not feed calf-milk replacements to goats as the formulas sometimes contain tallow, which kids can't digest properly. It can give them colic and scours, which can kill them.

It is a good idea to freeze some goat colostrum each season for emergencies. If we have a doe who has aborted, or lost her newborn kid to a predator, and we don't need her to be a foster mother, we milk her colostrum and store it. It will freeze very well for a year or more.

If we don't have any colostrum stored then we give artificial colostrum. We have made and used the following formula for more than a decade and have never lost a kid on it.

We feed the formula (warmed to 38°C) for the first two days only, then put the kid onto straight full-cream milk: powdered, fresh, goats' or cows' milk, it doesn't seem to make a difference. We have found that kids actually grow faster on full-cream powdered cows' milk than they do on their own mother's milk.

Artificial colostrum

- 1 L full-cream milk, fresh or powdered
- 1 beaten egg, very fresh (not duck egg, due to risk of salmonella)
- 1 teaspoon sugar
- 1 dessertspoon cod liver oil or cooking oil.

Mix all ingredients together. Give 50 mL for the first feed and increase this by 25 mL per feed until the kid is obviously satisfied. Give this formula for no longer than 36–48 hours, as after that it will be too rich and will cause the kid to scour. All ingredients must be included. If they are not, the kid will be fine for about 10 days but then begin to weaken and will finally die.

If you use cooking oil instead of cod liver oil in the formula, you will need to add vitamin drops containing vitamins A, E, D and C to the kids' bottles at the rate suggested by your vet. We give bottle-fed kids an injection of vitamins A, D E and B12 at six weeks of age and another lot at three months of age, when they receive vaccinations.

In drought years, we usually give an injection of these vitamins to all kids, and to any kid that isn't growing well at any time. You can see a response in 10–14 days. The kids will be livelier, have better coats and brighter eyes and will start to grow. If kids are not having 'playtime' running about, headbutting and generally playing the fool in the late afternoon, it is time to look at their nutritional state. This is especially important with kids that are artificially fed. It is also important to ensure that artificially fed kids don't get chilled or wet: without the antibodies contained in natural colostrum they are more prone to infection.

The importance of natural colostrum

Natural colostrum contains immunoglobulins (antibodies) vital for the health and growth of kids, as they are born with an underdeveloped immune system and no antibodies. In goats, antibodies cannot cross the placental barrier so newborns depend on receiving them through their mother's colostrum within 12 hours of birth.

Kids are also born with a very low store of vitamins A, D and E because, like antibodies, they cannot cross the placental barrier. These fat-soluble vitamins are of major importance and colostrum is the primary source. This is why bottle-fed kids must have full-cream milk, otherwise they will not be able to absorb these vitamins. The water-soluble B vitamins are synthesised by goats' rumens; because kids' rumens are not functioning they must receive the B vitamins from colostrum.

Colostrum is so important that a kid that doesn't receive either natural or artificial colostrum for at least 24 hours will die within 10 days of birth. If a kid is put straight onto milk without colostrum it will seem fine for about week then, even if it has been feeding well, will weaken and die.

Frozen colostrum must not be defrosted at too high a temperature. It should be defrosted at no more than 49°C, and fed at 38°C. If you defrost the colostrum at too high a temperature the protein forming the antibodies will clump and separate from the liquid part of the colostrum, destroying the antibodies and rendering the colostrum useless. We place the bottle containing the colostrum in a jug of hot (not boiling) water to defrost it. We

swirl the contents several times during warming to ensure that the colostrum in contact with the hot water on the outside of the bottle does not become too hot. We do not recommend defrosting colostrum in the microwave. Even on a very low setting, defrosting with great care, the colostrum may clump and separate.

Poor quality of colostrum and milk is often caused by such things as lack of good-quality paddock feed from drought conditions or soil deficiencies. If paddock feed is poor during a doe's pregnancy, she will require supplements of good-quality hay and a ration of grain such as cracked corn, barley or cottonseed meal (see Chapter 4). A supplement of approximately 200 g per day is usually enough to bring her into kidding and lactation in good condition. With cottonseed meal, 100 g per day should be sufficient because of its higher protein level. It is good practice to also give the does vitamin and mineral blocks.The quality of a doe's colostrum and milk is greatly influenced by her diet during pregnancy. If her diet is low in essential vitamins and minerals, her kids will suffer severely. This will be reflected in their poor growth, lack of vitality and lacklustre coats.

Udder problems

Sometimes a doe will not allow her kids to suck and will move away every time they touch her udder. This can be mistaken for poor mothering instinct but it is often caused by a sore tense udder, more common in young first-time mothers than in older does.

The solution is simple: milk the doe a little (feed the milk to the kid or save it by freezing), just enough to relieve the tension, or hold the doe so that the kids can latch on and feed. In some high-producing dairy goats, especially Saanens, this may need to be done several times before the problem is resolved.

If the udder is hot, tense, shiny and hard as a brick, then you have a problem. The doe has mastitis and will need antibiotics prescribed by a vet. It could also mean a more serious health problem (see Chapter 9).

Diarrhoea

Sometimes young kids develop diarrhoea which, if untreated, can kill them. Diarrhoea in kids can be caused by colibacillosis, salmonellosis and rotavirus.

The causative organism of colibacillosis is enterotoxagenic, *Escherichia coli* (*E. coli*), and it generally affects kids less than a week old, particularly those who don't receive enough colostrum (which contains antibodies). An early symptom is profuse white-yellow scouring, followed by dehydration and death. Septicaemia may occasionally occur. A scouring kid should be taken to the vet for faecal samples, which will require laboratory analysis. Antibiotics may sometimes be useful in treating the condition.

Salmonellosis causes scouring and deaths in kids and in stressed older goats in the herd. Its clinical signs include severe depression, fever, profuse yellow watery diarrhoea and dehydration. Dysentery (bloody diarrhoea) may occur. Salmonella infection can often be contracted by ducks contaminating the goats' drinking water. Ducks are known to be carriers of salmonella and can contaminate water due to their habit of washing their food before eating it. Your vet will arrange faecal cultures from rectal swabs, faeces and enlarged mesenteric lymph nodes. They will also do a blood test to reveal whether there is an elevated white cell count and other changes indicative of salmonellosis.

Rotavirus occurs in young kids, and its diagnosis requires laboratory analysis of faecal samples, to see whether the cogwheel-shaped virus is present. Prevention of infective diarrhoea in young kids rests on two things:

1 kids receiving quality colostrum in the first 12 hours after birth when their gut is still receptive to it, because this is the main protection against diarrhoea;
2 good hygiene in the kidding pens or paddocks. Good hygiene includes washing hands after you have finished handling one kid, before you handle another.

Prevention of dietary diarrhoea

Scouring, due to diet, can occur in young kids that are given skim milk or calf milk replacer. Calf milk replacer is formulated for calves and often contains tallow, which kids cannot digest. It may also contain other ingredients such as soybean meal (Baxendell 1988).

Kids can be fed with a commercial brand of suitable milk replacer (ask your vet) or with straight full-cream powdered milk, after they have received sufficient colostrum (have been fed colostrum for 36–48 hours, see above). They should have access to water from birth and will drink from three or four days of age. Milk consists of approximately 84% water so it may not strictly be necessary for them to have water, but we supply it anyway.

We keep does and kids in the kidding paddocks for the first two weeks after birth. These are small paddocks, close to the house, where we can keep an eye out for feeding or health problems, and for predators.

Predators

Many predators consider goats a favourite food because they are small and easier to catch than kangaroos and wallabies, in grazing areas they are usually more abundant, and there is more meat on a goat than on a rabbit or bandicoot. The kids are more accessible than joeys. Goats have a number of different predators, that can cause significant losses to producers each season. They include wedge-tailed eagles, dingoes, feral and domestic dogs, feral pigs, foxes and, occasionally, hungry goannas.

Our kidding paddocks include fallen logs, beneath which does hide their kids while they are feeding. The logs seem to be effective in protecting the kids from aerial detection and thus predation from eagles and hawks, but are not enough to protect them from other types of predators. Foxes and dingoes have noses and ears which appear to work like radar. They seem to know when there are kids around and we have seen them going from log to log looking for them. There are several solutions to this problem; vermin-proof fencing is one of them.

There are suggestions for vermin-proof fencing in Chapter 2, including designs for corner assemblies which do away with the need for stay posts. Stay posts are just like a ladder to a dingo, dog or fox. It is no use putting stay posts on the inside of the fence either, in a bid to outfox the fox. Goats also treat them like a ladder, and will be off to wherever the fancy takes them!

Dingoes (*Canis lupus*)

Dingoes evolved in south-east Asia 6000–10 000 years ago and arrived in Australia 3000–4000 years ago. They are thought to have arrived here with Indonesian fishermen and were

soon adopted by the Aborigines, who used them for hunting when pursuing kangaroos and other food animals.

Female dingoes weigh 12–15.5 kg; males weigh 14.5–24 kg. Size seems to be regionally determined and may be related to availability of prey. The largest dingoes in Australia were trapped in the Victorian Highlands and the smallest in the central desert regions. Their lifespan is approximately 10 years in the wild, although they live several years longer in captivity.

There are a number of different coat colours but the frequency of ginger dingoes decreases from north to south, in an approximately inverse relationship to human population density and the time since European settlement. This implies that there are more hybrids in south-eastern Australia (Corbett 1995).

Pure dingo females have only one oestrus season per year. It is considered that litters born from November to April are probably due to hybrids in the population. The main breeding season is from April to August and the litters are born in the dry cool or winter months with an average litter size of five pups, most of them male.

It is perhaps fortunate for goat producers that the alpha female (dominant bitch) in a dingo pack kills the pups of the other females, thus limiting the dingo population. This applies only in areas where pack structure has not been affected by human interaction. Poisoning, shooting and trapping usually remove the very old and young dingoes from the hierarchy, leaving the healthy middle-aged dingoes – the breeders and the best hunters. When the pack structure and pecking order are greatly disturbed, the pack breaks up into smaller units that do not have an alpha male and an alpha female. The result of the breakdown of pack structure means that all females will breed and raise pups. In a large pack with a defined alpha male and female only one litter, belonging to the top male and female, is raised each year.

The bitch will den in such shelters as old rabbit burrows (which she enlarges), wombat burrows, hollow logs or rock shelters, to name but a few.

Dingoes do not necessarily need to drink water either, as they often get enough water from prey when it is abundant. They have been found in the Simpson Desert 130 km from the nearest water when long-haired rats were abundant, which indicates that their range does not seem to be limited by the availability of water. Bitches also lick the urine and faeces from their pups' rears, to reuse the water contained in them: in the few thousand years that they have been in Australia dingoes have adapted well to climatic extremes.

A dingo's range (home territory) is controlled by population density and availability of food and water. For example, the average range in the Simpson Desert is 67 km and the average in Kosciusko National Park is 21 km. Loners (usually males), without a pack travel through pack territories, and the only interaction with those packs is aggression or avoidance.

Dingoes' behaviour patterns are governed by factors such as climate and prey activity. In Kakadu National Park, peak activity is from dawn to dusk with least activity at noon (Corbett 1995).

Our own experience has shown that dingoes are adaptable and will change their hunting activity to suit the prey – our goats. Our goats are shedded at night and go out to graze by themselves at daybreak. One morning the herd came back to the pen. Many goats

were covered in dingo bites, a number of them were missing, and dead and injured goats lay everywhere in the paddocks.

The Department of Primary Industries baited with 1080 (sodium monofluoroacetate, legal in Queensland) and we kept the goats locked in the pens until 9 am, checking the paddock for dingoes before letting the goats out. All went well for three days and then the dingoes attacked again. We let the goats out later and later but it made no difference – the dingoes must have realised that if they waited long enough the goats would eventually arrive. However, after the dingoes had taken the 1080 baits, the problem was eliminated for a time. That year we had a kidding rate of 180% and a weaning rate of 120%. The low weaning rate was mainly due to predation by dingoes and feral dogs prior to initiation of the baiting program. Losses such as this cannot be sustained and a control program must be carried out. If you are going to make a profit as a goat producer, losses due to predators must be kept to a minimum.

The local Environmental Protection Agency or Department of Primary Industries or equivalent will advise on legal and effective control methods such as shooting or baiting. Each state and territory has its own regulations for control of feral pests, including dingoes. These regulations are often subject to change so they are not included in this book.

If a baiting or other control program is to be carried out in your area, it is good practice to have as many properties as possible implement it at the same time to allow maximum culling of the population. Baiting, trapping and shooting may control some of the small breeding groups created by intermittent baiting and shooting since European settlement but they will not eliminate dingoes and feral dogs from an area, because when you kill a pack you create a vacant territory and another pack will soon move into it.

Concern has been expressed about the use of 1080 for the control of dingoes and other predators because of the fear of native animals eating the poisoned baits. This has happened when poisoned carrots were laid out to control rabbit populations, and wallabies and bandicoots also took the baits. When meat is used for baits to control dingoes, foxes, feral dogs and cats, however, kangaroos and wallabies will not take the baits.

Birds, such as wedge-tailed eagles and emus, appear to be immune to 1080 and eat the baits with no apparent effect. However, studies carried out in the US found that the lethal dose for three species of hawks and one species of owl is about 10 mg/kg of bodyweight, and for one species of vulture about 15 mg/kg. This means that these bird species are, like domestic fowls, more than 100 times more resistant to 1080 poisoning than dogs or dingoes (see Table 5.2).

On one very large station in Western Australia, with a severe dingo problem, emus were following the ute being used to disperse 1080 baits and eating baits as fast as they could be laid. The emus were monitored for approximately a week by biologists working in the area, for any adverse effects from the 1080; none were noted (Corbett 2003, pers. comm.).

If you are baiting it is a good idea to inform as many local people as possible, because of the risk of working dogs taking baits when droving stock near your property. Dogs will be dogs and they love to set off on a little exploration now and then, even while working stock. The consequences can be tragic.

It is often said that 1080 poisoning must be painful. Some humans that have been poisoned by 1080 said that though they experienced convulsions and cardiac effects, they did not experience pain (see Chapter 11).

Table 5.2 Relative resistance of various species to 1080

Animal	Quantity of 1080 to kill (in mg/kg liveweight)	Relative resistance (dog = 1)
Dog	0.08	1
Cat	0.3	4
Opossum	0.3	4
Wallaby	0.3	4
Sheep	0.45	5
Pig	0.5	6
Rabbit	0.8	10
Horse	1	12
Magpie	1.3	20
Human	2–5	25–60
Sparrow	4	50
Mallard duck	8–16	100–200
Domestic fowl	14	175

Source: Pestfact A001/87A, Clark and Allen (1987)

Finally, it must be stated that, however reluctant producers may be to lay baits to control dingo and feral dog populations, the viability of a grazing enterprise may require it. The survival of many enterprises is seriously threatened by uncontrolled dingo and feral dog populations and some sheep and goat producers have been bankrupted by continual stock losses.

Good control of dingo and feral dog predators involves several factors.

- Make sure fencing is suitable to keep goats in and dogs out.
- Have does and young kids near the house so it is easier to keep a watch on them.
- Consider the use of flock guardians such as maremma dogs or alpacas.
- Reduce canine predator numbers via an approved baiting, trapping or shooting program (Corbett 1995; Clark 1976; Pestfact AO09/094E/0594P).

Wedge-tailed eagle (*Aquila audax*)

With a wingspan of up to 2.5 m, wedge-tailed eagles are the largest bird of prey in Australia. Their natural prey consists of wallabies and small kangaroos and, when these are scarce, various ground-dwelling and swamp birds and reptiles. Most prey is taken on open ground, and the eagles usually feed there. They also eat carrion and thus do a good job of keeping the environment clean; it is when they begin to take stock, such as newborn lambs and poultry, that they come into conflict with graziers and farmers.

In the early 20th century, when eagles were found feeding on the carcasses of sheep and lambs it was thought that they had killed them. Bounties were paid for their destruction and in Queensland alone 10 000 were paid between 1927 and 1968. This practice has ceased because it was realised that the eagles usually only attacked sick, poor or dying animals. Today they are protected in all states (Readers Digest 1988).

Wedge-tailed eagles will take newborn kids, which can be quite a loss if the kid is from one of your best bloodlines. Providing portable shelters made from pine or other light

materials is a simple way to protect kids from predation by eagles and hawks: don't use corrugated iron, because it is too hot in summer and too cold in winter. Leaving fallen logs in the paddock can also provide protection from eagles and hawks because wedge-tailed eagles usually take their prey on open ground.

Wedge-tailed eagles kill only what they need and take only one kid at a time. If an eagle is nesting and feeding chicks, though, it will prey every day. Consider using herd guardians such as dogs or alpacas (discussed below).

Other predators

There are other predators such as goannas and feral pigs. Some of our kids have been, we suspect, taken by goannas but the number has never been significant. Wild pigs can be a problem in some areas but adequate electric fencing or guardian dogs will usually resolve it.

Herd guardians

Maremma dogs and alpacas are often employed as guardians in goat herds.

Maremma

The Maremma sheepdog is an ancient breed that has been used to guard sheep flocks of sheep for centuries. It is a large and attractive dog with a strong build and hardy appearance:

- height at withers: dogs 65–73 cm, bitches 60–68 cm;
- weight: dogs 35–40 kg, bitches 30–40 kg.

Maremma have black pigmentation on the mucus membranes, eyelids and the central and toe pads. Their coat is white to ivory and can be 8 cm long on the body. In the winter, they grow a warm downy undercoat. Their eyes are ochre to chestnut brown. Their temperament is well suited to the job of guardian, and Maremma are intelligent, brave, decisive and totally devotion to their charges (Federation Cynologique International 1992)

Bonding

Maremma will guard anything they have bonded to, including poultry, sheep, goats, cattle and horses. They must be bonded to the species when they are young; many Maremma breeders begin the inter-species bonding when the pups are 6–10 weeks old and the kids are at weaning age.

The pup is put into a small enclosure with the kids and fed like any other pup, preferably by the owner. You should stroke it a little, talk to and contact it once or twice a day. If the pup is not allowed social contact with you, when it is older it may not allow you into the paddock with your goats. For example, one producer believed that he should have no physical or social interaction with the dog at all –finally he had to shoot it because it would not let him into the paddock. In fact, the dog would attack him if he went anywhere near the goats as it didn't recognise him as a friend, rather than a predator.

How many Maremma are needed to effectively guard your goats? If there are few local predators, one dog per group of goats will be fine. In areas where there are large packs of dingoes or feral dogs you will need at least two dogs for each group of goats, to back each other up in the not-infrequent event of a pack attacking the herd.

Figure 5.4 A Maremma guarding newborn kids

Photo courtesy of OlandO Boer Goat Stud, Qld

Though Maremma need to be socialised with humans they are working dogs not pets, so children should be discouraged from playing with them and distracting them from their duty of guarding the herd. They are not a dog which has been bred for obedience or ability to learn commands in general. Their primary duty is as guardian and they will not work, fetch or roll over to please their human friends, as other dogs will. Maremma are large enough to kill brown bears and they have formidable strength. This, coupled with their lack of obedience and trainability, makes them unsuitable as urban pets.

Though most Maremma will bond and work well with a herd, not all are suited to the task. Unfortunately, not all breeders have culled dogs with timid or overly aggressive natures, so these unsuitable temperaments are passed on to their offspring. This is a pity because it damages the reputation of a courageous and loyal dog that can be very useful in reducing stock losses.

Handling

You will need to have an escape-proof pen, with a roof, in which you can confine the Maremma when you are working with the goats. If they are not locked in their pen they will get under your feet or, in the belief that you are trying to injure *their* goats when you are foot-trimming and so on, may attack you. It is easier if they are out of the way while you are working with the herd.

Working

In a paddock they won't seem to be doing much; apart from moving when the herd moves, they appear to mostly sleep. However, appearances are deceptive. If an eagle, fox, pig, dingo or anything they consider may be a threat to the herd is anywhere in sight, they are instantly alert and will fight to the death to protect their herd. We have never heard of any that have turned tail and run.

Maintenance

Maremma do quite well on a diet of good-quality dry dog food fed in the recommended quantity and access to clean drinking water at all times. They need vaccinations and boosters and a suitable heartworm preventative. Like other dogs, they need an annual check-up and booster shots for the various canine diseases.

Alpacas

Alpacas are members of the four South American camelid species and are closely related to but smaller than llamas. They are intelligent and gregarious animals with strong herd social instincts. Both females and males are very protective of each other and of their young. Alpacas are generally very alert to any animal approaching their paddock and have excellent eyesight over kilometre distances. Normally almost soundless, alpacas can emit a high piercing scream when aroused to potential danger, alerting property owners. Adult males develop very sharp fighting teeth designed to emasculate their rivals, but castration before two years old usually prevents these from forming. Alpacas are normally gentle towards humans and other animals that are not considered threatening. If smaller predators such as dogs and foxes attack, alpacas chase them away or stamp on them with their forelegs. Alpacas are fast runners and can run down foxes and smaller dogs (AAA 2002). Many producers now use alpacas for guarding their herds and say that they are ideal for the job.

Suitability for guard duty

It is recommended that only alpaca wethers (castrated males) 18 months of age or older, be used for guard duty: entire males will cause a problem with the does when they are cycling because they want to mate them. If female alpacas are used as guards, then the buck will want to mate them. Do not run male and female alpacas together because they will seek each other's company and not that of the herd.

Some alpacas are unsuitable for use as herd guardians because they do not have the aggression and personality required. Many alpaca breeders train wethers as guardians before selling them, by running the younger males with older wethers that are protecting sheep or goats.

Age

The protective instinct rarely develops in alpacas before they are 18 months old, so do not buy alpacas younger than that because they will not be up to the job.

Cost

An alpaca wether will cost $250–500; because they have no breeding potential they are less expensive than entire animals.

Care

They will need to be drenched for parasites at the same time as your goats are drenched because they are susceptible to both cattle and sheep worms, which can kill them if not controlled. Unlike goats, they usually develop some resistance to intestinal parasites by the age of two years. It is good practice, however, to have a faecal egg count test done on them when you have your goats tested.

Figure 5.5 Fagin guarding Adare Co. lambs

Photo used with the permission of the Australian Alpaca Association Inc.

Alpaca wethers need to be shorn once a year but because alpacas have soft padded feet with two fairly soft toenails, instead of hooves, you do not have the task of hoof-trimming. They are said to be more environmentally friendly than other breeds of animals, including humans. Their ground foot-pressure is 36 kPa, which is much less than sheep at 82 kPa and cattle at 185 kPa (AAA 2002).

Accustom your alpacas to the farm dogs and to your presence by keeping them in a small paddock near the homestead and hand-feeding them when you first purchase them and whenever they are not needed for guard duty. Further information is obtainable from the Australian Alpaca Association (see Appendix 1).

6

Tagging, marking, vaccinating, weaning and foot-trimming

Tagging

To save time and trouble, we try to tag kids on the day that they are born and find it convenient to do this when we drench their mother. If we tag kids on the day of birth when they are still very close to their mother and not too mobile, there is no confusion about who is their dam. If tagging is left more than a few days, it can be difficult to decide which kid belongs to which doe. A doe sometimes literally kidnaps a kid from another doe, and it can also be difficult to tell which kid belongs to which doe when the kids are all piled together for sleep or they are all running around playing. We use an adult tag on kids. They appear enormous at first but within a week the kids are used to them. Some producers use the inexpensive, small plastic loop-type tags on kids and replace them with an adult tag when the goats are earmarked or tattooed and the bucks marked (castrated).

It is a good idea to use a tagging system that shows the sex at a glance. If the males are always tagged in one ear and females in the other, you know immediately which sex is which. We tag right ear for females and left ear for males because it is more convenient due to the way that our yards are set up, but the official tagging system is to place the tag in the right ear for males and the left ear for females.

When we go into the paddock at kidding time we always carry a small kit that consists of a notebook, pen and container with cotton swabs soaked in methylated spirit, tags and tag applicator. We use this to tag newborn kids and to record their tag number, the number of the doe that has just kidded, how many kids there are and a brief description of each kid. If the kid moves and you pierce the vein when tagging, there will be quite a lot of blood. Put pressure on the hole by pinching it between your thumb and forefinger for a minute and the bleeding will usually stop quite quickly.

It is important to position the tag correctly in the ear. Place the tag a third of the way down the ear from where it joins the head and in front of the large vein that runs down the

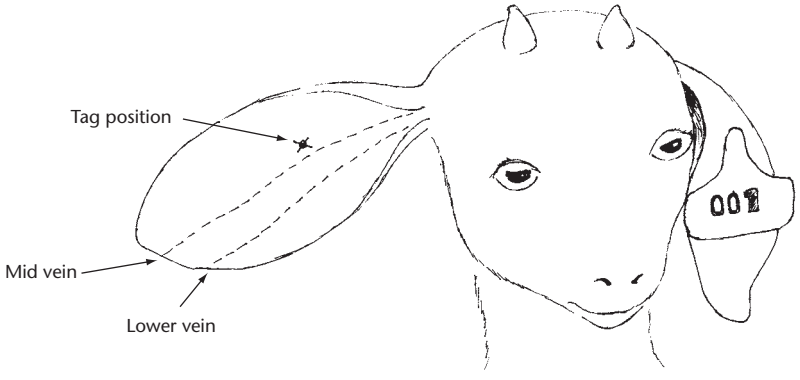

Figure 6.1 Eartag position

middle of the ear. If the tag is positioned too far down the ear it will catch on fences and feeders etc. and may rip out. If placed behind the middle vein and towards the lower edge of the ear it will eventually rip out because the ear is quite thin in that area (see Figure 6.1).

If the tagging is done when the kid is newborn then it is simple to do. If you have no experience tagging, ask another breeder to let you watch them doing their tagging. Most breeders are happy to show others how to do this.

To eartag your kids and goats you will need the following basic equipment:

- a tag applicator suitable for the tags you are using – there are many different types of tags and each has a different type of applicator;
- methylated spirits or antiseptic to clean the ear prior to tagging;
- cotton swabs to apply the methylated spirits or antiseptic;
- container or jar for the methylated spirits, wide and deep enough for the applicator, with tag, to be dipped in prior to tagging the goat;
- eartags.

To tag a young kid, follow these steps.

1 Place the kid on your lap so that the ear you wish to tag faces out. For example, if you want to place the tag in the right ear you put the kid on your lap with its head facing to your left (see Figure 6.2).

Wipe the ear with methylated spirits or antiseptic, using a cottonwool swab: we usually fill a small bowl or container with cottonwool swabs and pour methylated spirits over them so they are ready to use as required.

Pick up the kid's ear with one hand. Check where the central vein is then position the applicator correctly, making sure that the number will be at the back of the ear. Squeeze the jaws of the applicator together to place the tag. Most applicators release automatically when the tag is placed, but some don't and you will need to release the clip that holds the jaws closed. It is a good idea to check this before beginning to tag the kids. It can be a little difficult to figure out how to release the clip when you have a frightened kid on the end of the applicator, trying to escape!

Usually the kid will run to its mother and begin to suckle as soon as you release it. This reaction to anything which causes stress, pain or fear is quite normal. If you

Figure 6.2 How to hold a kid for tagging and vaccinating

have not been able to identify a kid's mother before then, you can usually do so when it reacts this way.

During the next week, check for infected ears. Infection can happen even when you have been careful with tagging procedures, because kids may pick up an infection from dust or manure in the paddock or pens, for instance. If there is infection we usually bathe the ear to remove any scabs or debris from the area then apply some Betadine or other antiseptic.

Infection after tagging does not occur often, but it is more likely when the weather is rainy or damp immediately after tagging. An ear may blow up enough to look like a small balloon. This is easily fixed by nicking the swollen area with a sterile scalpel and syringing out the debris (pus) with antiseptic (we use 5 mL of 6% hydrogen peroxide in 250 mL of warm water) or a commercial wound-cleansing product. You may need to syringe the infected earlobe once daily for two or three days before it clears up properly. Make sure that you don't get any water down inside the kid's ear canal or you may end with a worse problem. Due to the shape of the ear canal, it is difficult for water to run back out once it has entered and a severe infection may result.

Tagging older kids

You may need some help to tag an older kid. If we are changing tags on kids that were tagged with a temporary tag at birth, we use a pair of footrot shears to cut the stem of the temporary tag so that we can remove it. A small pair of garden secateurs works just as well.

Have the assistant seated on a chair which has no arms and hand them the kid, with the ear that you are to tag facing outwards. They can use the forearm and elbow of one arm to hold the rear of the kid down and the other hand to hold the kid's head in position. The tag

is inserted into the ear in the usual fashion. Don't let the kid's feet touch the ground or chair, as this will let it get a grip, it will struggle to escape and be very difficult to hold.

With older goats, while one person holds the head of the goat to be tagged, the operator inserts the tag. We often tag these animals by ourselves. We do this by standing astride the goat, holding the head in one hand while controlling the goat with our knees. We can then place the tag. It takes some practice, but is not too difficult. We would not recommend trying this with a large buck, though. For larger goats, a headbail should be used and for bucks we often use the cattle crush.

Marking

Most buck kids will not be required for breeding and, unless you are breeding for an Islamic market which requires entire males, you will need to castrate or neuter the young bucks. There are several reasons for neutering bucks not required for breeding:

- it is easier to handle wethers than adult bucks;
- wethers do not develop the strong odour that entire bucks do. Some consumers complain that bucks' odour contaminates meat, although our experience has not shown this to be true;
- many people believe that the meat from wethers is tenderer than buck meat;
- wethers do not fight as much or as violently as bucks;
- you can run does and wethers together for much of the year.

The time to mark (castrate) your bucks is when they are between 10 days and six weeks old. After this time the procedure can be quite painful and cause problems, especially in the case of elastration, which involves placing a rubber ring around the neck of the scrotum between the abdomen and the scrotal sac.

Knife castration

Knife castration must be done by a trained operator or under the direction of a vet. We will not describe it here, as your vet will need to instruct you in the correct way to do it. Knife castration entails opening the scrotal sac and excising the testicles, after severing the *Vas deferens* with a scalpel or blade. The procedure does not seem to cause a great amount of pain but there is a risk of infection, as in any surgical operation. Infection seems to occur more often in goats than it does in cattle.

Burdizzo

Kids can also be rendered sterile by a Burdizzo, an instrument used to bloodlessly crush the testicular cord and so render the kid sterile without breaking the skin. There is thus no chance of infection, but the disadvantage is that if the procedure is not carried out correctly the animal may not be properly sterilised – with disastrous consequences for your breeding program! If you are going to use the Burdizzo, you will need instruction from your vet or an experienced operator.

A Burdizzo for sheep and goats costs approximately $250. Its jaw width should be 40–45 mm. The Burdizzo for cattle is much larger, with a jaw width of around 80 mm.

Figure 6.3 Front view of how to hold a buck kid for marking

Elastration using marking rings

The third method of sterilising young bucks is by elastration. The procedure involves the application of a rubber ring, made especially for the purpose, around the neck of the scrotum to cut off its supply of blood and nutrient. If done correctly, there is no chance of any animal remaining partially fertile, as may happen with a Burdizzo. Also, kids are less likely to get an infection because the skin is not cut so there can be no entry of bacteria into an open wound.

To elastrate kids, you will need a ring applicator, marking rings and a chair. There are a few different types of ring applicator, so try them to see which you prefer. There are also different brands of marking rings, all less than 20c each – so don't attempt to cut costs by using rubber bands. They are not durable enough and can break. You will also need a chair, if you can't squat comfortably.

Our marking is carried out in the following manner, but each producer should make a routine that suits their own requirements.

1. Muster the does and kids into the yards and separate the does from the kids. If not separated from the work area, the does may try to attack you because they believe that you are hurting their kids, or they may just get in your way.
2. The assistant, seated on a chair, holds the kid by its front legs, on its back with hollows of its hips resting on the assistant's knees (see Figures 6.3 and 6.4).
3. The operator loads a ring onto the prongs of the applicator, then lifts the scrotum and locates the two testicles.
4. The operator squeezes the handles of the ring applicator to open the jaws as wide as possible and slips it over the scrotum, making certain that both testicles are inside

Figure 6.4 Lateral view of how to hold a buck kid for marking

the sac and that neither has slipped back into the abdominal cavity. They check that there are no nipples caught under the ring, then twist the applicator up and out to release the ring from it. The kid is now elastrated (marked) and can be released to its mum.

5 If you are vaccinating at the same time, turn the kid around so that it is the right way up and facing across the assistant's knees, then vaccinate the kid on the neck just behind the ear, as described below.

6 If a temporary tag is to be replaced by a permanent one, this is a good time to do it. Always cut the shaft of the tag on the outside of the ear, never the inside, because it is easy to accidentally snip an earfold or poke the shears into the kids eye if cutting on the inside of the ear. Note the tag number before releasing the kid.

The kid will show signs of discomfort after a few minutes as the circulation is cut off from the scrotum. It feels much the same as your finger does when you put a rubber band around that. The kid may bleat and throw itself on the ground and show other signs of discomfort, but this soon passes and within half an hour or so it has usually forgotten about it.

The scrotal sac begins to shrink after a few days and within two months falls off without leaving any discernible scar. Occasionally a kid reacts to the rubber and the skin may weep around the ring. We put Betadine spray on it and that fixes the problem. You can mark buck kids anytime from 10 days old, but the procedure should be done before they are six weeks of age.

Vaccinating

There are producers who do not believe in vaccinating their stock, just as there are parents who do not believe in vaccinating their children. We do not share that belief.

If stock are not vaccinated, when they encounter new infectious organisms they will have no antibodies (immunoglobulins) with which to fight them. Some of the infected stock will live but a large proportion may die. Most vaccines cost no more than 30c per dose and a goat is certainly worth more than that.

It is best to order your vaccine two to three weeks before the intended vaccination date. Due to high demand during the breeding season, there may be a delay before it is supplied.

To vaccinate your goats you will need the following equipment:

- a supply of vaccine, either 3-in-1 or 6-in-1;
- a vaccinating gun or, if you have only a few kids, 2 mL syringes;
- a supply of size 20–21 gauge 18 mm (3/4 inch) needles;
- methylated spirits or antiseptic to swab the vaccination site prior to giving the injection;
- cottonwool swabs to apply the methylated spirits or antiseptic;
- a container for used syringes and swabs.

It is recommended that vaccinations be placed high on the neck just behind the ear and that they always be done in the same position. The reason for this is that often a 'cold abscess' forms at the injection site, meaning that when material from it is cultured no bacteria can be grown. It is caused by the adjuvant and is not really a problem. If it becomes very large it can be lanced and cleaned using a syringe containing cool boiled water with a little hydrogen peroxide (5 mL of hydrogen peroxide to 200 mL of water; see Chapter 9).

How to vaccinate

You can do the vaccinating alone or with an assistant. Immobilise the kid's head in the same manner as when you are tagging, wipe the injection site with a methylated spirits-soaked swab then give the injection.

With your free hand, pinch a fold of skin high on the kid's neck between your thumb and forefinger. Carefully insert the needle under the pinched-up fold and inject 1 mL of the vaccine subcutaneously (between the skin and the muscle). Figure 6.2 shows the correct position in which to hold a kid for vaccination.

To vaccinate an older kid or adult, immobilise them as you would when tagging them.

The following section, written by Dr Sally Oswin BVSc, CSL, is reproduced with the kind permission of Dr Oswin and CSL and explains clearly the reasons for vaccination. The use of trade names in this section does not mean that the author of *Farming Meat Goats: Breeding, Production and Marketing* endorses or otherwise the products mentioned.

Vaccination recommendations for goats in Australia

Several important bacterial diseases that result in reduced meat quality, reduced production or death in your goats can easily be prevented using a correct vaccination program.

The bacterial diseases, which are prevented by vaccination, are five clostridial diseases (of which tetanus and pulpy kidney are the most common) and caseous lymphadenitis (cheesy gland). Goats are particularly susceptible to these diseases.

More recently, we have become aware that goats can also contract a disease called leptospirosis, which can also be prevented by vaccination.

Tetanus is a very common clostridial disease that infects goats. Tetanus bacteria produce spores that are found in soil, manure and throughout the farm environment. Your goats are at risk of contracting this fatal disease if they are not correctly vaccinated. The spores can enter the body through wounds as a result of trauma, dehorning, disbudding, castration, hoof-trimming, dog bites, fighting bucks, grass seeds and lacerations around the vulva at kidding.

Sometimes an animal can contract tetanus without there ever having been an obvious wound at all. Once the spore enters a wound, it will produce a very potent toxin that affects the nervous system. It can result in your goat experiencing severe muscle cramps, stiffness, and often a very painful death. Treatment is usually unsuccessful and very expensive but in most situations, the goat is found dead and the case is difficult to diagnose.

The bacterium *Clostridium perfringens* type D causes pulpy kidney or enterotoxaemia. This disease is picked up from the environment also and the spores can survive in the intestinal tract of normal goats. When conditions in the bowel are favourable, particularly if the goat is then fed a rich diet of grain or lush feed, the bacteria can multiply and produce a potent toxin. The first thing that people tend to notice when their goats have pulpy kidney is dead goats. The disease will often attack the healthiest and best-conditioned goats in the herd and it typically causes sudden death.

Cheesy gland is a chronic disease in goats that causes abscesses of the lymph nodes, and often the internal organs. It is responsible for reduced production in goats by causing reduced growth and reduced milk or fleece production. Cheesy gland is also a major cause of carcass trimming and condemnations in abattoirs.

CSL makes a Glanvac range of vaccines to protect sheep and goats against these diseases. Glanvac 3 is our recommended vaccine for goats as it protects goats against the above three diseases. Other clostridial organisms can also cause disease in goats, but the incidence is not reported to be high. If your farm is in liver fluke area, black disease can be a problem.

This disease occurs when migrating fluke activate clostridial bacteria living in the liver and cause toxin production. Black leg and malignant oedema are two other clostridial diseases that can infect goats, causing acute tissue and muscle damage (gas gangrene) and rapid death. Glanvac 6 will protect goats against these disease as well as tetanus, pulpy kidney and cheesy gland, but vaccinating with Glanvac 6 is only recommended when black disease, black leg or malignant oedema are known to be a problem on the property.

Goats that are being vaccinated for the first time will require two 1 mL doses under the skin approximately four to six weeks apart. Kids can receive their first vaccination any time from four weeks of age, but ideally before three months of age. In most cases, kids will be protected by antibodies in their doe's colostrum up until around 12 weeks of age. It is often most convenient to vaccinate kids at marking time (when castrating) and then give their second vaccination at weaning. After the initial two doses, a booster dose is recommended every six months in all goats due to their increased susceptibility to pulpy kidney.

Leptospirosis is a bacterial disease that is very well recognised in cattle and is also capable of causing disease in goats. Leptospirosis has been known to cause abortion in does, stillbirths, weak kids and possibly death in young kids.

The disease is also a very topical one because it is possible for goats to pass it on to humans. People tend to experience severe flu-like symptoms but it can be very debilitating

and can last for many weeks or cause recurring illness. The bacteria are typically transmitted from goat to goat to human via infected urine or reproductive secretions. This puts goat producers in a fairly high-risk situation, especially dairy goat producers who spend a lot of time in close contact with their stock.

CSL makes a vaccine called Leptoshield that is approved for the prevention of leptospirosis in cattle and is also very effective in preventing leptospirosis in goats. Leptoshield will prevent goats from contracting the disease and if kids are vaccinated before they pick up the disease from the environment, then probably (as definitely demonstrated in cattle) they are unlikely to even shed the bacteria so that the risk of spread to humans and other goats is minimal. Leptoshield should be administered in two initial doses that can be given at the same time as Glanvac 3, and thereafter a booster dose once every 12 months as required.

When vaccinating, it is very important to use sterile needles and avoid contaminating the vaccine with unwanted organisms. The vaccine needs to be stored at refrigerator temperature.

Weaning

Goat kids can be weaned anytime from three months of age onwards. If they can be left for a month longer, it will allow them to maximise their early growth. However, this extended period of suckling may not be convenient for producers who wish to obtain three drops of kids in two years. We believe that does should be allowed to dry out for at least six weeks before rejoining and becoming pregnant again. This permits the udder and teats to shrink to normal size and the doe to come back into good breeding condition before she is joined. We breed our does only once per year.

If possible, does should be moved to a paddock well away from the kids being weaned. Keep kids in a paddock near the house so that they can be fed and monitored each day. It is not usually necessary to keep the does and kids apart for more than three or four weeks. Most does, even dairy types, are dry by this time, but there are some exceptions and these may need to be kept apart from their kids for a little longer.

When the kids are removed from their mothers, if they have a good pasture you may not need to feed them. If kids are fed, their growth will be faster and they will reach market weight earlier. If you decide to feed them, the ration can be built up to 225 g per day. The cost of extra feed must be considered, before making the decision to do this.

It is not advisable to feed pure lucerne hay to goats, especially wethers and buck kids, that do not have access to open pasture over long periods. Lucerne can cause urinary calculi in goats, more readily in males and most often in castrated males. The problem is precipitated by an imbalance in the calcium:phosphorus ratio in lucerne. The ratio of calcium to phosphorus in feed should be at least 2:1.

Hay should be placed into hayfeeders, not just dropped onto the ground. Putting hay on the ground results in a great deal of waste and also makes the goats vulnerable to parasites picked up from the ground, such as Barbers Pole worm (*Haemonchus contortus*) and coccidia (*Eimeria* spp.). Hayracks are available from a number of suppliers, but it is quite easy to make your own using galvanised mesh panels that have been bent into a U shape

with three hooks attached, so that they can be hung on a fence or in the shed. Standard galvanised mesh fencing panels 100 cm high are ideal.

We recommend that sorghum or milo be avoided unless it is cracked, because whole grains are often passed through the digestive tract undigested. If you are feeding grain, it is important – even imperative – that kids and adults have enough hay or pasture to provide good ruminal scratch (roughage) or they could develop several conditions which may cause serious problems. One of these conditions is enterotoxaemia (pulpy kidney), often caused by grain supplementation and low fibre in the diet. A low-fibre diet allows the feed to pass too slowly through the gut, permitting a build-up of toxins from *Clostridium perfringens*. This bacteria is almost always present in goats' gut and only causes a problem if there is an overgrowth of it. Pulpy kidney should be vaccinated against (see above).

Feed formulators recommend that the grain supplement have a protein level of 12.5–14.5%. Our feed pellets are formulated at 16.5% because we find that the extra protein gives better results – our pastures are poor, based on granitic sand. Protein deficiencies have a negative effect on growth, so it is important that any deficit in pastures be addressed by adequate supplementation both before and after weaning.

At weaning, we drench the kids for worms. They have usually been drenched at least once before, but the stress of weaning can lower their resistance to worms and other parasites so we drench them again with a broad-spectrum white drench such as albendazole that treats most roundworms and tapeworms. Unless there are exceptional circumstances, such as threadworm (*Strongyloides papillosus*) or coccidia, we never drench kids younger than six weeks old.

Kids frequently lose weight for the first few weeks after weaning because they are distressed at being removed from their mothers and don't appreciate their change of diet, but soon adapt and begin to put on weight quite quickly. Most are settled again within four days of being removed from their mothers. The first two nights are usually sleepless ones for the owners, though, because the kids spend what seems to be all night bleating and calling for their mothers. It is sometimes tempting to give in and let them go back to their mothers, but don't: they will settle in a day or so and you will be able to sleep again.

Foot-trimming

Weaning is also a good time to trim overgrown hooves as this allows kids to become accustomed to having their feet handled from a young age. It is surprising to see how overgrown feet can become in the few short months since the kids were born.

A goat that has overgrown feet cannot walk well and often finds it difficult to travel far enough each day to eat enough to nourish both herself and her growing kids. Overgrown hooves often trap particles of sand, twigs, manure and other detritus and this can lead to some very nasty infections. A severe infection may cripple the goat. Goats' feet often need attention (see Figure 6.5). A wether with overgrown feet may not eat enough to grow well for the market and a buck may have feet that are so painful that he cannot work properly.

In the wild, goats usually live in fairly rough terrain, which often includes rocky outcrops or hilly areas which naturally wear down the hooves. A domesticated herd of goats is usually run in much softer country where their hooves do not wear down so much.

Figure 6.5 A badly overgrown hoof

A pair of footrot shears, available at a reasonable price from most rural suppliers, is essential. Pneumatic air-operated footrot shears make the job much easier, but their expense is justifiable only if you have large numbers of goats. Be very careful if you use these power shears, because they can cut off a finger as easily as they can trim a hoof.

A small pair of carpenters' pliers with the blades sharpened is useful for nipping difficult-to-cut pieces of hoof when they are very hard. Some goats have very hard hooves and these often do not wear down in soft paddock conditions. Other goats have much softer hooves which wear down easily and these goats never need their feet trimmed. Feral goats with black hooves seem to be in the latter group. South African Boer goats also have dark hooves but they are often very hard hooves that can be very difficult to trim.

To make a useful tool for removing small rocks and other material from the hooves, take a 4" (10 cm) nail and drive it into a piece of wooden broom handle 12 cm long. Remove the head with a hacksaw and bend the end of the nail at an angle of approximately 25°. Flatten the tip with the hammer, file off any rough bits and sharpen it a little. This makes a handy small stone-pick.

It is often easier to trim hooves when the goats have been running on wet pasture for a few days than it is when they have been running in very dry paddocks for a long period.

The hooves of goats with very hard horn may be trimmed using one producers' solution: he stands his goats on wet carpet for a few hours, which apparently softens the hooves enough so that the job is not difficult. Some producers let goats stand on wet bedding straw in the yards for a few hours, a method which also seems very successful in softening hooves.

To trim the feet of a goat, proceed as follows. Remember that pregnant does should be handled with great care.

1 Immobilise the goat in a goat-handling crush or headbail, or tie its head to a post or rail. If the goat is in a commercial goat-handling crush follow the manufacturer's

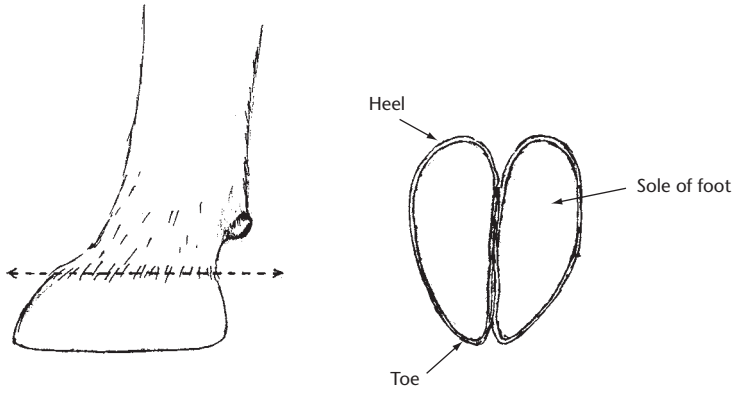

Figure 6.6 A correctly trimmed hoof

instructions because there are several models with different methods of carrying out various operations.

2 When the goat is in a headbail or tied to a post or rail, straddle it or stand beside it facing toward the front of the goat and lift up the front hoof, letting the goat's knee bend up naturally, and examine the hoof.

3 If the horn of the hoof is overgrown and curled under the foot so that the soft sole can no longer contact the ground it often traps small rocks and other foreign material underneath it, which is very painful for the goat – imagine having a rock or a splinter trapped under your toenail. These pieces of grit or manure can cause infection if they are trapped for very long, so the overgrown hooves must be trimmed and all foreign material removed. Another hoof problem is spurs of overgrown sole (soft tissue under the foot) on the inner side of the two back sections of the hoof, near the heel. These spurs force the two sections of the hoof apart, which makes walking very uncomfortable.

4 Begin by carefully removing any foreign objects, such as rocks, from the hoof. Some may not be accessible until you have trimmed some of the overgrown hoof.

5 Trim any spurs from the inside edge of the heels. Be careful when trimming these spurs, as there is a small bridge of tissue joining the two sections of hoof near the heel and if you accidentally nick this the goat will have a very sore foot.

6 Trim away any overgrown horn from the foot so that when you are finished the hoof will sit squarely on the ground. The trick to getting the correct angle is to trim the hoof in a line parallel with the hair-line on the hoof (see Figure 6.6). Do not cut the heels too high at the back or the goat will sit too far back on its foot, which will throw its balance out. It is also important not to cut the front of the hoof too high (dumping the hoof), as this will throw the balance forward.

7 To trim the back feet, turn and face the rear of the goat and either stand beside it or straddle it. Many people use the second method because they can use their knees to control the goat's sideways movements.

8 Bend over, lift up the foot from the rear, and trim it to match the other feet. When trimming their back feet, be prepared for goats to fight and kick; goats often don't mind you handling their front feet but will misbehave when you attempt to do the same with their back feet. We have no idea why!

The first time you trim a goat's hooves usually takes a while, but with practice it only takes a few minutes.

If you accidentally cut too deeply and draw blood, the wound often bleeds freely. The bleeding usually stops within a short time and should be sprayed with an antiseptic, such as buffered iodine, to take care of any bacteria entering the wound.

7

Nutrition

Many people believe that a goat will eat anything, from your best sheets off the clothesline to old tin cans! This is a fallacy – goats are reasonably selective in their choice of feed. Many people also believe that goats instinctively know if something is not good for them and reject it – another fallacy. Many goats are poisoned by their consumption of tasty but deadly plants and shrubs such as poison peach (*Trema tomentosa*), rattlepod (*Crotolaria* spp.) and oleander (*Nerium oleander*). We hope that this chapter on the nutrition of goats from birth through to the feeding of working bucks will be useful. Poisonous plants are discussed in Chapter 11.

Nutrition is of major importance to meat goat producers, whose ideal is to gain the earliest and fastest growth, and the highest fertility, with the lowest possible dollar investment. Most requirements of nutrient levels can be calculated with reasonable accuracy and this chapter discusses how to feed your goats for maximum growth, weaning percentage and fertility.

Ideally, we would feed the goats everything they wish to eat, on demand (ad lib). However, this would soon bankrupt most enterprises.

Some very experienced producers know what their stock need by appraising their condition and the state of their pasture. They know if supplementary feeding is necessary, what is needed and how much. They have usually learnt by experience, sometimes very costly experience. Achieving maximum growth from the least input is not easy. Fortunately, some extensive studies have taken most of the guesswork out of it.

Goats are by preference a browsing animal, whose dietary preferences are more in line with those of small game ruminants than those of cattle (McMahan 1964). They prefer trees, shrubs and woody weeds to lush pasture grasses. If they have only very lush green pasture to eat it can precipitate a condition known as grass tetany. Unlike pigs, goats cannot live on grain alone but need ruminal scratch (roughage) in the form of grazing or hay. Without this, they will soon succumb to any one of a number of fatal diseases (see Chapter 9).

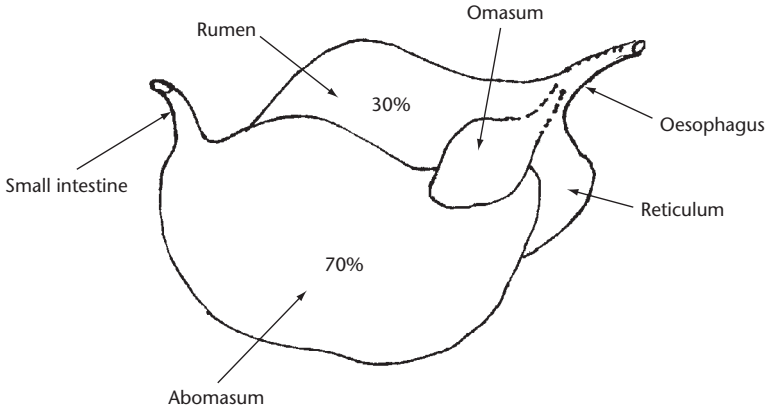

Figure 7.1 Digestive system of a kid

Digestive system

Goats' nutrient requirements might be better understood if we first look at how their digestive system functions (Raupp 1999; Caceci 2003; Ciappesoni 2003; Haenlein 1992c; Newfoundland & Labrador Dept of Agriculture 1998; Terry 2003). Humans are monogastric – as the name implies, we have a single-chambered stomach. Goats, cattle and sheep are ruminants with a four-chambered stomach. The word 'ruminant' is derived from the Latin *ruminare*, 'to think', and a goat or cow does appear to be thinking deeply as it stands chewing its cud (ingesta).

A ruminant's digestive process begins with prehension, the taking of feed into the mouth. Goats mainly use their lips for this, whereas cows mainly use their tongue. Once in the mouth, feed is ground, chewed and mixed with saliva into a bolus (ball) of a suitable size to swallow. Saliva consists of water, electrolytes, mucus and enzymes, and has a pH of 8.2 (it is alkaline). The high pH of saliva is needed to deal with the large quantities of acid produced by the reticulum and rumen. It is created by the addition of bicarbonate ions in the salivary ducts.

When it leaves the mouth the food, now called cud, enters the oesophagus and is pushed by peristalsis (muscular movements) into the first chamber of the stomach, the rumen.

A goat's stomach occupies approximately 75% of the abdominal cavity, filling most of the goat's left side and extending significantly into the right. The stomach has four chambers: the rumen, reticulum, omasum and abomasum (see Figures 7.1 and 7.2). The rumen is the largest section of the stomach and is joined to the reticulum by a low fold of tissue that allows the stomach contents to flow freely between the two chambers.

Ruminants eat grasses and other plant materials but do not directly produce enzymes to digest the cellulose, which is the primary plant metabolite. Instead, they rely on the huge microbial community in the rumen to make enzymes to digest plant materials. Microbial densities can be as high as 1 trillion microorganisms per mL, the highest density in nature. Ruminants feed off fermentation waste products of microorganisms, mainly acetic acid, propionic acid and butyric acid. The rumen, where food is broken down and fermented by billions of protozoa and bacteria, is where the ruminal microorganisms help to build

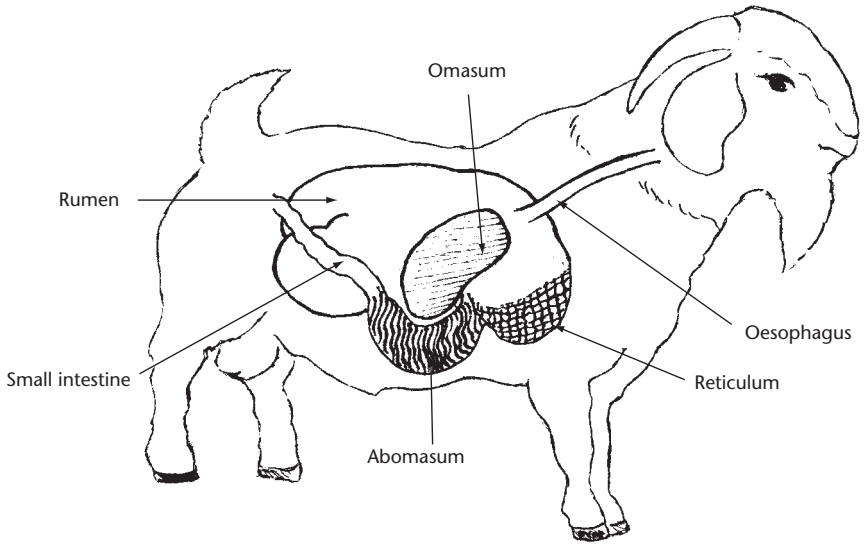

Figure 7.2 Digestive system of an adult goat

protein and manufacture the B vitamins needed by the goat. However, the rumen does not form vitamin B12 and it must be supplied from the goat's diet in the form of cobalamin (cobalt).

The process of fermentation also helps goats maintain their body heat. If you have ever felt the heat generated in the interior of a compost heap, you will understand how heat is generated by fermentation.

While goats feed, they sometimes pause and regurgitate cud back into their mouth from the rumen. They will chew the cud for a minute or two then swallow it again for further processing in the rumen. Occasionally goats burp to rid themselves of fermentation gases produced in the rumen. If they cannot burp up these gases it may cause bloat and, sometimes, death (see Chapter 9).

When the particles are fine enough, the material passes from the rumen into the reticulum. Any foreign objects such as wire settle into the honeycomb-like walls of the reticulum where they may cause obstruction or, if they penetrate the stomach walls, peritonitis. Obstruction caused by swallowing wire and nails etc, is known as hardware disease or hardware stomach.

From the reticulum, the cud passes to the omasum. The omasum removes water and absorbs volatile fatty acids and possibly minerals and nitrogen. The volatile fatty acids thus absorbed are used by the goat for energy.

The cud (partially processed food) is then forced from the omasum into the abomasum, which is the true stomach. There the cud is digested by hydrochloric acid (HCl) in the same manner that monogastrics (humans) digest their food.

The small intestine is where the final breakdown of the cud occurs. The upper portion of the small intestine secretes enzymes, bile and pancreatic juice to aid in the further breakdown of the cud.

The end products of the digestion process are absorbed by the lower intestine, where bypass protein and fats have their nutritional effects.

Figure 7.3 If mum is eating it, it must be good!

The large intestine is where the residue from digestion is deposited. There, water, minerals and nitrogen are absorbed and some fermentation occurs before the material residue is excreted as waste (dung).

Digestive system of kids

Kids have a relatively small rumen and it is not until they are several weeks old that it develops enough for them to begin digesting roughage as well as their mother's milk.

When kids are born, their rumen, reticulum and omasum do not function and they depend solely on milk for nourishment. When they swallow milk, it goes directly to the abomasum through the oesophageal groove. Each time they swallow, a flap of skin at the entrance to the rumen folds over to form a groove that bypasses the rumen and sends milk straight to the abomasum to be digested by stomach acid.

From an early age, kids will nibble tiny amounts of feed. Figure 7.3 shows a one-week-old 2nd × doe kid tasting the hay its dam is eating. As kids grow older, their rumen becomes active and starts to enlarge and its population of microorganisms begins to increase, as do the reticulum and omasum, in response to the change in diet. By the time they reach adulthood, the rumen is much larger than the abomasum with which the kids digested milk when newborn.

Kid nutrition and growth rates

Growth rates from birth to weaning

The growth rate of kids is controlled by several factors, including genetics, nutrition, day length, parasite burden, health and, to some extent, the age and size of its dam. Tables 7.1 and 7.2 show the average growth rates from birth to 150 days in full-blood South African Boer goats.

A comparison of the average daily weight gain of two full-blood South African Boer goat kids (Table 7.2) highlights the different growth rates of the sexes. Both kids were twin births.

Table 7.1 Average daily weight gain of kids from birth to weaning

Growth of kids	Daily weight gain (g)
100 days	163
150 days	
Singles	197
Twins	163
Triplets	143

Source: Aucamp and Venter (1981).

Table 7.2 Comparison of male and female growth rate from birth to weaning

Registration no.	Sex	Status	Birth weight (kg)	60 days (kg)	Weaning	Daily weight gain (g)
BCV FT 003	M	Twin	3.75	20	30 kg @117 days	256.4
BCV FT 002	F	Twin	3.75	17	28 kg @ 117 days	239.3

The daily weight gain from birth to weaning at 117 days was 256.4 g for the buck and 239.3 g for the doe. At six months of age, the buck weighed 49.5 kg and the doe 47.5 kg. At maturity, the buck 'Bantu' weighs 110 kg and the doe 'Anna' weighs 90 kg.

This rapid early growth of South African Boer goats means that kids and wethers reach market weight at an earlier age than most other breeds. The growth rate slows by six months of age to be more in line with that of other goat breeds. However, the goats' average weight, at any age, is heavier than most other breeds of goats. South African Boer goats are used extensively in cross-breeding programs throughout Australia and internationally.

Our full-blood South African Boer goats have better-than-average growth rates for south-east Queensland. Twin buck kids achieve an average of 225 g per day growth to 100 days, and twin doe kids 190 g per day to 100 days. One buck kid achieved a phenomenal 310 g daily weight gain and another (not ours) achieved 320 g per day. There are two main reasons for these improved growth rates: the blood lines are superior:(National Australian Champion blood lines) and good nutrition. Our full-blood South African Boer does are fed during pregnancy and lactation, and the feed and husbandry of the other high-achieving buck kid was also excellent.

Some factors that influence daily weight gain of kids from birth to weaning are their birth weight, the time of year (influence of day length), the availability of feed and its quality. Figures 7.4–7.9 illustrate expected growth rates for two breeds. There is not a lot of difference between them, because hybrid vigour in first-cross animals increases expected growth rates.

Kid nutrition

From birth, give kids access to clean drinking water. We have seen them tasting water from two or three days of age and actually drinking from five or six days of age. Goat milk is approximately 84% water, so it is not strictly necessary for young kids to have access to it, but in our warm subtropical climate we provide it anyway.

Goats need a good supply of clean water at all times (ad libitum), especially in summer or when they are lactating. Dry adult does drink more than 2 L daily; when lactating or in hot weather they may drink more than 10 L per day.

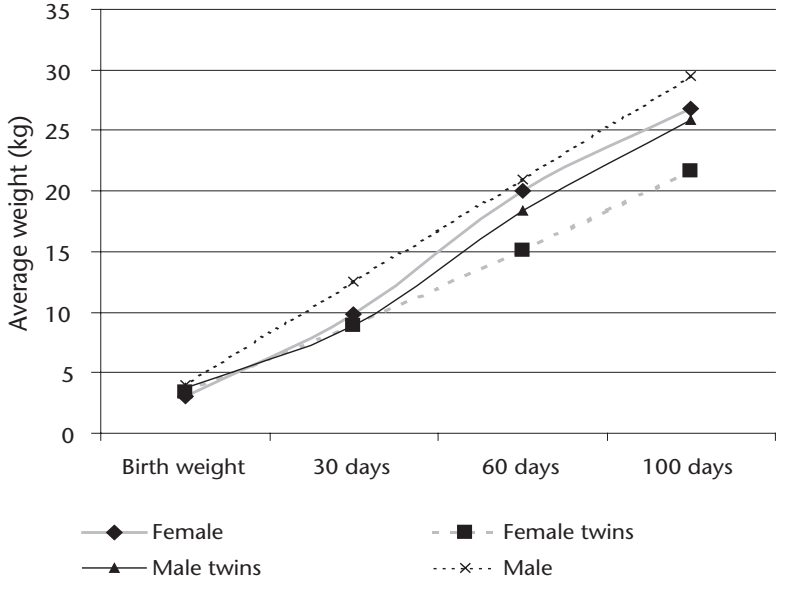

Figure 7.4 Weight gain of full-blood South African Boer kids

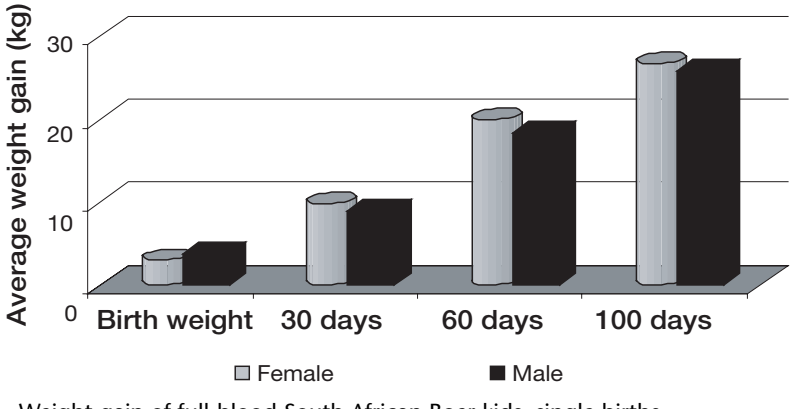

Figure 7.5 Weight gain of full-blood South African Boer kids, single births

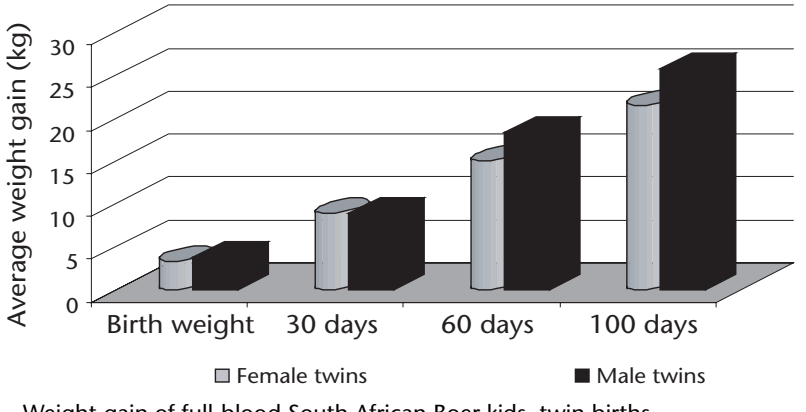

Figure 7.6 Weight gain of full-blood South African Boer kids, twin births

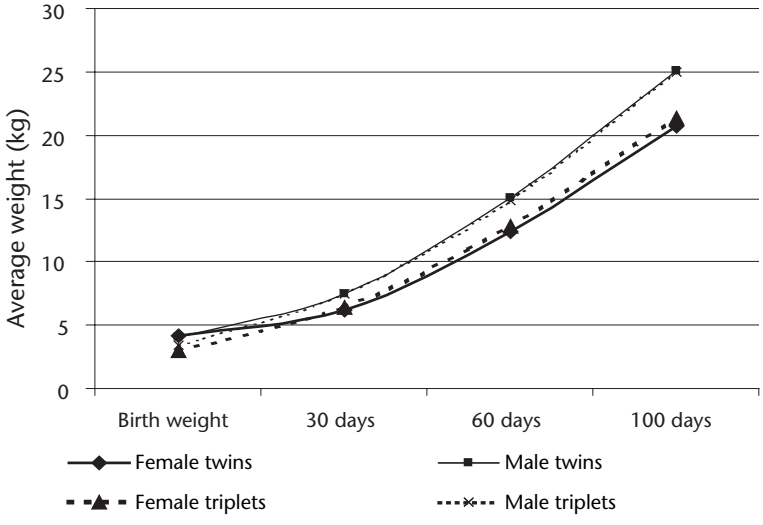

Figure 7.7 Weight gain of South African Boer × dairy kids

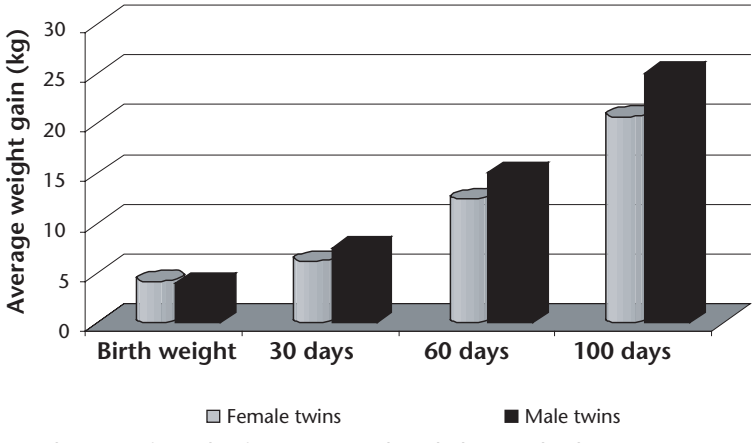

Figure 7.8 Weight gain of South African Boer × dairy kids, twin births

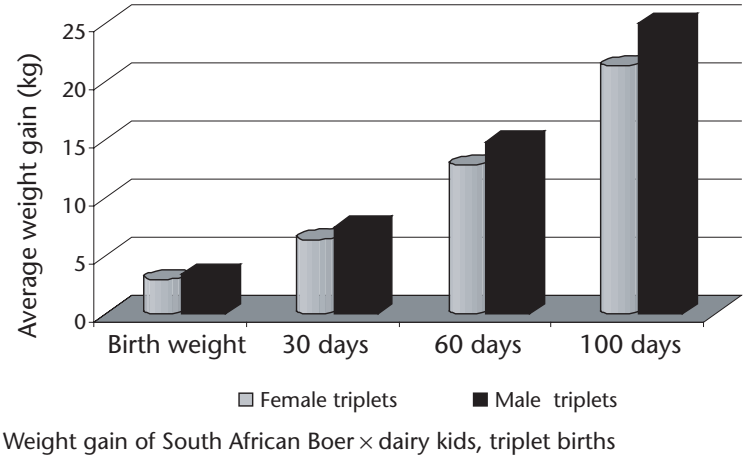

Figure 7.9 Weight gain of South African Boer × dairy kids, triplet births

Kids need access to good pasture from an early age and, from around 10 weeks old, they should be given a daily supplement of a concentrate such as cracked corn or barley. Barley is a very good grain for goats and is the grain we use in our goat pellets, when it is available. Properly formulated goat pellets are sold through local feed stores. Begin with 100 g of cracked grain or pellets per kid daily and increase by 50 g per kid each day, until they are receiving approximately 200 g per kid per day. The better the nutrition, the faster the kids grow. When the growth slows at six months of age the supplement can be decreased to 125 g daily or, if the pasture is good, you might end supplementary feeding.

The cost of supplementary feeding must be considered when deciding whether to feed your weaned kids. If feed costs are high, as they were during the 2002 drought, it may not be economic to feed them.

In a US study (Poore and Green 1995) 48 goats, approximately six months old, were divided into four groups based on bodyweight and sex. The goats were brush-type (feral) sired by Tennessee Stiff Leg bucks on brush-type and Stiff Leg does (Stiff Leg is a US breed). Studies have shown that young growing goats should have a diet containing 68% total digestible nutrients and 14% crude protein, which they cannot obtain from hay alone. Two of the study groups were fed only high-quality hay, and the other two groups were fed all the hay they could consume, plus 0.25 lb/head/day (115 g) of a 16% protein grain mix consisting of 84% corn, 14% soybean meal and 2% limestone ($US160/ton). The hay was high-quality second-cutting mixture of orchard grass and clover, and cost $US80/ton. Both groups had free access to sheep and goat mineral. The goats were weighed on two consecutive days at the beginning and end of the 71-day experiment.

In a previous trial goats were fed 1 lb (450 g) of grain plus hay, and there was significant response to the supplementation. However, growth rates did not improve enough for that level of feeding to be economically viable. In the study discussed above, grain supplementation was reduced to 0.25 lb (115 g) per day. The goats grew slowly and had poor feed conversion, so the study concluded that even the lower level of supplementation was not economic after weaning as the goats did not reach slaughter weight any faster. It did state, however, that results might be different with faster-growing goats such as South African Boers and their crosses.

If the climate in your area means that there is often a shortage of good pasture in late December, the kids can be fed a good grassy lucerne, barley hay or other good-quality hay. As previously mentioned, cracked grain or goat pellets can be also fed at the rate of 125 g/day/kid. This amount may not seem large, but kids fed a supplement such as this will reach market weight a month or so earlier than they otherwise would. If kids are not being raised for a milk-fed capretto market, they can be allowed out to graze with their mothers.

Some markets require milk-fed kids because their consumers believe that hay, grain or pasture affect flesh colour and taste. If your market for capretto demands kids have access only to their mother's milk, it is important that the mother be given as much supplementary feed as necessary to sustain a good quantity and quality of milk.

If kids are to be sold as milk-fed capretto they must be confined when their mother goes out to feed in the pasture – if the kids are outside, they will graze! Kids can be shedded (confined in a shed) or kept in a yard without access to pasture. If they are shedded they will need artificial light and vitamin D supplements.

In dairies, they are often taken away from their mothers soon after birth. This is common in France, where kids are left with their mothers for two or three days after birth to receive their mother's colostrum then removed to a shed or yard where they are fed via bottles or a lamb bar. The does soon forget that they had kids and settle down to the daily routine of grazing and being milked. If you require goat milk for yourself or for selling, you will need to keep the kids away from their mothers until they are two or three weeks old, when they will lose the urge to suckle.

Artificially fed kids grow well, but attention to hygiene is vital. All bottles, teats, utensils, bowls, troughs or lamb bars should be thoroughly washed and rinsed after use and before refilling. We always sterilise bottles and equipment and have rarely had a problem with scouring due to bacterial infection.

Nutrition for older goats

The nutritional requirements of older goats (six months on) are basically the same as those of kids – water, energy, protein, vitamins, minerals and roughage in quantities that depend upon various factors: age, sex, breeding status (pregnancy in does and working bucks during mating), lactation, bodyweight and season. The decision whether to give additional feed depends on the feed available on the property, cost and whether it is important for goats, such as wethers for the meat market, to grow more quickly and/or be heavier for a particular market.

The best and cheapest feed for goats and other ruminants is grass**.** Grazing paddocks for goats should be small, so that goats can be rotated into different paddocks at frequent intervals. There are two reasons for frequent rotation:

- pasture recovers more quickly if it is not eaten lower than 4 cm. When eaten down below that height the soil dries out and pasture can become sparse and take a long time to recover;
- frequent rotation helps to control contamination of pasture by intestinal parasites.

Goats have five basic nutrient requirements:

1. water – goats need access to water from three or four days of age;
2. energy – this is derived mainly from carbohydrates consisting of sugars, starch and fibre. Energy is also derived from fats. These food elements are converted to volatile fatty acids in the rumen by bacteria; the acids are absorbed and used as energy;
3. protein – this is a source of amino acids for protein synthesis and a source of nitrogen for ruminal bacteria;
4. minerals – precise requirements have not been established, but basic needs are known;
5. vitamins – only small quantities are needed, but a lack of any soon shows in the form of slow growth, rough coat, lack of energy or a potbelly. Vitamins most often lacking are A, D and E. Goats synthesise vitamin C in their tissues and vitamin K (essential for blood clotting) and B group vitamins (except B12, cobalamin) are formed in the rumen by bacteria.

Water

Approximately 72% of an adult goat's bodyweight is water, and goats require a clean and plentiful supply of water at all times. As mentioned previously, lactating does can require 10–12 L of water per day and if the temperature rises above 40°C they could need twice that amount. The consequences of low water intake can be serious, including impaction of the rumen, decreased lactation, dehydration and death. Indirect consequences include starvation or slow kid growth due to insufficient milk, decreased feed intake leading to pregnancy toxaemia or ketosis, and slow growth rate of all goats (Petersen 1995).

The quantity of water your goats drink depends on various factors:

- the amount of moisture in the feed;
- surface moisture such as dew and rain;
- whether a goat is lactating;
- ambient temperature;
- taste;
- quality.

The quality of the water is affected by its composition and some external elements.

Salinity

The 'salinity' of water means not only its sodium chloride content, but other inorganic salts such as magnesium, calcium, sulphates and bicarbonates. Goats can adapt to high salt levels of >5000 mg/L but generally prefer <2000 mg/L (Petersen 1995). If you add salt (sodium chloride, also known as stock salt) to feed, the level of salt in water should be less than 2000 mg/L.

Goats' adaptation to high salt levels in water must be done gradually. Older and heavier stock cope better with higher salt levels than do young weaners. Stock that are turned directly into a paddock where the only source of water is very high in salts, i.e. >5000 mg/L, often refuse to drink for extended periods. When they finally succumb to thirst, they often drink large quantities of the salty water and a number may die.

Nitrates

Stock are frequently poisoned by nitrates, usually as a result of eating plants with high nitrite content, such as native couch or ryegrass, especially when these plants are stressed by water deficit during dry periods. Nitrites are also found in water but not usually at a level that is toxic to goats. See Chapter 11 for more information on nitrite poisoning.

Sulphates

If water has a high sulphate level and a copper deficiency in soil or feed there may be a problem with scouring, which is the most common effect of high sulphate content in water.

Alkalinity

Most water is slightly alkaline. A pH level of 7.0 is neutral, a reading below that is acid and a higher pH is alkaline. Most standing water has a pH of 7–8. Water with a pH of 10 is highly alkaline and contains carbonates. Most water has an alkalinity of less than 500 mg/L and is not harmful. Water with a pH value below 6.5 (acid) or above 8.5 (alkaline) can cause digestive upsets in stock, resulting in rejection of the water, depressed appetite and

consequent loss of production. Animals may perish even if they apparently have adequate water. Adding alum can correct a high pH but this should be done with care, as alum is highly acidic. Water with a pH below 6.5 can be treated by adding lime.

Algal growth or bloom

Some species of algae in still fresh water can be toxic to livestock if temperature, water nutrient levels and wind conditions combine to produce large masses of algal growth (see Chapter 11).

Temperature

In hot weather animals require more water. Shade is helpful – leaving some trees in the paddock when clearing and planting improved pasture is a good idea. If the water is salty (brackish), consumption in summer may almost double. Generally, animals prefer water at or below body temperature and avoid warm water. In hot conditions they prefer cool water (Markwick 2002).

Energy and protein

Unless grass and browse is in short supply, energy and protein are mainly obtained from the paddock. Improved pastures such as rhodes grass or pangola oversown with secca stylo in the warmer regions, and ryegrass and clover in more temperate areas, for instance, provide better feed than native pasture species. Improved pastures are more economical than feeding hay.

When your finances and time permit, you should develop improved pastures. This is initially expensive but it does pay dividends, as our own experience showed during two drought years.

We had $3000 not earmarked for anything in particular, so we decided to develop a 12 ha block that had almost nothing on it. The native bluegrass was no more than 4 cm high and quite sparse. We had this area yeoman-ploughed, spread with superphosphate and sown to rhodes grass and secca stylo. The area was fenced with a seven-strand plain-wire electric fence, using star posts and ironbark strainers. The total cost, including the hire of the tractor and operator for the ploughing, was $2800. If we had not developed the paddock we would not have been able to keep our goats during the drought, as the cost of feed was too high. With careful management of our improved paddock (and selling half of our commercial herd), the goats survived in reasonable condition.

Leucaena, a leguminous tree native to Mexico and Central America, can be grown and fed to stock. It has a high protein and energy content but also contains a chemical called mimosine, which can be fatal unless stock are inoculated with a bacteria that can break down this chemical in the rumen. In Queensland this bacteria, commonly known as a 'rumen bug', is available free from the Department of Primary Industries & Fisheries. The usual procedure is to inoculate only 10% of the herd, who will spread the bug to the rest via saliva as they lick each other, and share feed and water troughs. The inoculant comes with full instructions from the department.

Energy

Goats need energy for maintenance and productive processes. It is released by the enzymes produced by ruminal microbes at the beginning of the digestive process. If goats have

insufficient feed, or feed that is difficult to digest because it has lignified (hayed off) in late autumn or early winter, they won't meet their body's energy requirements, with several adverse consequences.

Energy deficits lead to reduced growth rates in kids and weaners, low fertility in does and bucks, lowered resistance to parasites and disease and, in severe cases such as starvation due to drought, death.

Plant cell walls contain lignin, which gives structural strength and increases as time passes. By late autumn or early winter, pasture in many areas of Australia has become dry and brown and is heavily lignified. This 'hayed-off' pasture usually contains a large amount of indigestible silica, which means that there is less metabolisable energy available and supplementary feeding may be necessary. The ruminal bacteria that break down fibre from plant cells find it difficult to break down lignin, so the more lignin there is in the feed the less is the energy released by the digestive process.

Metabolisable energy

Metabolisable energy (ME) is the unit used to measure the energy content of feeds. ME is the amount of energy remaining after losses in faeces, urine and gases (methane and carbon dioxide) produced by ruminal microbes fermenting the feed. ME is measured in megajoules per kilogram of feed dry matter. To allow meaningful comparisons between feedstuffs, the nutrient content of all feeds is expressed on a dry matter basis (DM), that is, a moisture-free basis.

Since ME is difficult to measure, it is usually calculated from the dry matter digestibility (DMD) of feed using an appropriate equation (Standing Committee 1990). The greatest loss of energy during digestion is lost via faeces – DMD is the proportion of dry matter consumed that is not excreted in the faeces. DMD is usually expressed as a percentage and can be determined using a laboratory procedure calibrated against DMD values for feeds that have been fed to sheep. For example, wheat stubble with little leaf material is heavily lignified and contains a significant amount of indigestible silica. It may have a DMD of 40% with a calculated ME of 5.3MJ/kg DM (Milton 1998). Tables 7.3 and 7.4 show the wide variation in ME levels of different forages and grains.

Weaned goats require a diet of 55% DMD (~7.5 MJ/kg DM) to meet their maintenance energy requirements, based on a dry matter intake of 2–2.5% of live weight and maintenance requirement of 0.4 MJ/kg 0.75/d (mean of the limited range of estimates cited by Norton 1985: Milton 2001).

Energy is used more efficiently as the dietary level of ME rises and it can be stored in the animals' body fat. In times of protein shortage, these reserves can be mobilised and used as an energy source.

When goats' daily energy requirements are met and exceeded, the surplus energy intake can be used for growth, lactation and reproduction. If needs are not met, growing goats will experience slow growth and delayed puberty. Older goats will experience a decline in fertility, weight loss and a decline in milk production.

Protein

The tissues of the body consist mainly of water and protein. Protein contains the nitrogen needed by the ruminal microorganisms to manufacture their own protein consisting of the amino acids, which are later digested by the goat.

If the goats' protein intake is too low, the digestion of carbohydrate will slow down. This will affect growth rate, pregnancy, lactation, fertility and general condition of kids and adults. A slow growth rate means a longer time before market weight or breeding age is reached. In pregnant does a very low protein diet can lead to abortion; lactating does may produce insufficient milk to sustain their kids.

Labels on bags of goat feed pellets or mash list the crude protein (CP) content of the feed. This figure is arrived at by determining the total nitrogen content of the feed then multiplying that by 6.25 (because most proteins contain about 16% nitrogen). Therefore, the nitrogen concentration × 100/16 gives a crude measure of protein content. The percentage of crude protein does not tell you how much protein is actually available – some protein is unavailable because it is bound to the fibres of the feed due to heat damage. Heat causes a reaction between the protein and carbohydrates in feed, changing the protein so that it becomes bound to the fibre and is indigestible or unavailable.

Proteins are the building blocks of life and are made up of about 20 different amino acids that are needed for livestock to grow, breed and live (PISC 1990; Agriculture, Food & Rural Devlopment 2003). If readily available protein is unobtainable due to drought and/or cost, a substitute is reasonably inexpensive non-protein nitrogen that can be synthesised into protein – stock urea, formerly known (at least in Queensland) as prilled urea. This form of non-protein nitrogen is synthesised into protein by the ruminal bacteria. Urea should not comprise more than 2.25% of the grain fed to goats and should be introduced gradually, over a few weeks, so that rumen microorganisms have time to adapt to the level of non-protein nitrogen. Urea must be completely dissolved before being added to feed and must be thoroughly mixed in. If one or two goats consume more than an equal share of urea it will poison them.

Urea toxicity: Urea can be a very useful and reasonably inexpensive protein supplement, but it must be introduced into the diet gradually over a period of three weeks or so.

Urea is an important natural compound in the physiological processes of goats, but can be highly toxic if consumed to excess. Most of the urea formed in the liver is excreted through the kidney, a portion passes into the rumen where it is hydrolysed to ammonia and used for protein synthesis (Vercoe and Frisch 1970). Excessive amounts of urea can cause a toxic build-up of ammonia in the bloodstream (Morris and Payne 1970; Kromann et al. 1971).

Urea should not supply more than a third of the total crude protein in forage or roughage-type diets and not more than half in a concentrate diet. It is generally believed that a level of 44 g/100 kg bodyweight at a single feed will result in acute toxicity (Subcommittee on Goat Nutrition 1997).

Crude protein is usually divided into two types: rumen-degradable protein (RDP) and undegradable dietary protein (UDP), which is not digested by the rumen. RDP includes any non-protein nitrogen such as urea. If the diet supplies more RDP than there is ME available for microbial protein synthesis, the liver converts the excess nitrogen to urea which is then excreted by the kidneys.

The protein content of even good-quality grain and hay varies considerably. The same is true of almost all feeds. Variation in nutrient levels is due to several factors:

- whether the paddock was fertilised and, if so, before or after planting;
- what it was it fertilised with;

- rainfall or irrigation during the growth period;
- climate or region;
- when it was planted (season and before or after rain);
- in the case of hay, at what stage it was baled;
- in the case of grain, when it was harvested.

Many other factors influence the protein and energy content of hay and stockfeed and thousands of books have been written on the subject. Table 7.3 lists the average nutritional values of some grain and seed and Table 7.4 lists the average nutrient value of fodder. Table 8.3 (in Chapter 8) lists the average nutritional values of shrubs and fodder trees.

Roughage

Roughage is vital for dietary fibre and should comprise approximately 3% of a goat's bodyweight daily; goats can eat up to 10% daily.

If they are not eating all the hay on offer, reduce it by approximately 25% per day until the goats eat all the hay provided. Adult goats will consume 1–1.5 kg of hay each day. Hay is expensive and if it is not eaten within a day or so, goats often avoid it so it is wasted. If there is good browse in the form of shrubs and woody weeds there should be no problem with goats receiving enough dietary fibre. However, if there is insufficient browse then a good-quality lucerne hay, or any good-quality hay such as barley, rhodes grass, hatch or grassy-clover hay etc. can be fed. The type of hay you choose depends on local availability and cost. If you choose low-cost hay, pay attention to its protein levels – some hay has such little protein that it qualifies more as bedding straw than hay!

In most cases, hay is best harvested just before it flowers, when protein and nutrient levels are at their peak. Hay that is harvested late in the season when it has begun to lignify and its seeds have begun to fall will be much less digestible. If the lignified hay has suffered heavy rain there is often very little protein left in it, because the rain will have washed out its protein and left it only good for roughage.

Goats often avoid very coarse hay that consists mainly of stalks with little leaf material present. Frequently, unless they are very hungry indeed, expensive lucerne hay is also mostly wasted because goats often eat only the leaves and ignore the coarser stems. If they are very hungry they may eat the stems. A simple solution to the problem of stems being discarded and wasted is to put the lucerne hay through a mulcher then feed it as chaff. Lucerne can be purchased as chaff and in a convenient pelleted form. **Note that, because of its high calcium level, it is not advisable to feed lucerne as the sole roughage to bucks confined without access to grazing, as it can cause urinary calculi**.

If hay is fed on the ground and is contaminated with urine or dung goats will not eat it. If hunger forces them to eat hay contaminated with dung, they may ingest parasites shed by other goats. It's not a good idea to feed goats via a suspended hay-net if kids have access to it, because they can become caught in it and strangle.

Goats digest the fibre of low-quality forages more efficiently than sheep or cattle. Watson and Norton (1982) showed that goats' superior ability to retain feed longer in a relatively larger rumen and to maintain ammonia at higher levels resulted in more effective digestion of low-quality pangola grass hay (Milton 2001).

Feed takes 11–15 hours to pass through a goat's digestive tract, although this varies with the type of feed and individual digestions.

Be careful that hay and fodder is free of unwanted chemical residue. For example, during the 2002 drought some desperate cattle producers in Queensland fed their stock sugarcane tops sold by enterprising cane farmers. Neither the cane farmers nor the graziers realised that many of the previous generation of farmers had used DDT to control pests in sugarcane and that DDT residue in the soil adhered to the cane tops when they fell to the ground after harvest. When the stock was sold, the graziers received Condemn Notices due to the DDT content of the carcasses. To add insult to injury, they also received an abattoir bill for the handling and disposal of the carcasses.

Daily nutrient requirements

Different classes of goats require different levels of nutrition according to their age, bodyweight, breeding status, market requirements, pregnancy, level of activity, time of year and, in the case of bucks, whether they are working.

A dry doe weighing 50 kg will require 1.5–1.9 kg of dry matter (DM, discussed above) each day. A lactating doe of similar weight will require 2.3–3 kg. For every 9 kg bodyweight, DM intake should be increased by 300 g.

Listed below are the basic requirements for growth, lactation and maintenance of bodyweight and condition.

1. Daily intake of CP (crude protein) for lactating does should be 13% of the DM.
2. Daily intake of CP for dry does should be around 10% of the DM.
3. Kids, because they are growing, will need >17% CP. Kids intended for the export market receive a ration containing 22.5% CP because rapid weight gain is required.
4. Feed should contain 18–30% fibre on a DM basis.
5. A daily feed intake equalling 1% of bodyweight is required for energy maintenance.
6. For every 600 mL of milk produced, does need to ingest 100 g of energy.
7. Calcium (Ca) and phosphorus (P) are required in the ratio of Ca 2:P 1 to avoid problems including urinary calculi. Dietary calcium should comprise 0.4–0.8% of DM and phosphorus should be 0.4% of diet (DM).

The only way to discover the exact nutrient values in your feed is to have a feed test analysis. A number of companies can do these tests. We briefly explain here some of the terms that may be used in the test results (Agriculture, Food & Rural Development 2003; Standing Committee 1990; Milton 2001; Raupp 1999; Morse and Sedivee 1990; Ontario Agriculture & Food 1997; University of Nebraska 1997; Brown 1981).

DM

Test analysis refers to dry matter, which means the feed minus its moisture content. Measuring nutrients this way allows for easier and more accurate comparisons between different feeds.

Dry versus as fed basis: you can convert from an as-fed basis to a dry basis using the following formula:

As fed = dry basis × (% DM ÷ 100)

For example, a feed such as buffel grass silage has 50% DM and hay has 80% DM. On an as-fed basis the silage contains 8.5% protein and the buffel grass hay contains 9.6% protein. It seems that the hay has more protein, but if you compare the protein content on a DM

Table 7.3 Average nutrient value of grain and seed

Feed	Digestible matter (%)	Organic matter (%)	Acid detergent fibre (%)	Digestible dry matter (%)	Crude protein (%)	Metabolisable energy (MJ/kg)
Copra meal			33.2		21	13.5
Cottonseed: *Gossypium* spp.	92.78	94.06	28.50	73.59	30.46	11.04
Lupin: *Lupinus* spp.	91.81	96.45	25.85	75.19	30.71	11.28
Maize: *Zea mays*	38.51	94.44	28.00	63.76	7.72	9.56
Oats: *Avena sativa*	84.80		22.37	69.78	11.01	10.47
Peanut: *Arachis hypogaea*	92.26	94.08	25.17	78.13	35.68	11.72
Rye: *Secale cereale*	40.40	90.36	22.25	72.53	17.33	10.88
Sunflower: *Helianthus annuus*	83.65	93.52	32.68	70.90	33.80	10.63
Triticale	88.45	95.47	5.73	84.06	12.39	12.61
Wheat: *Triticum aestivum*	83.63	94.69	11.34	80.21	14.21	12.03

basis the hay is 12% (9.6 ÷ .80 = 12) and the silage is 16% (8 ÷ .50 = 16). Animals will gain more protein per kg of dry matter from the silage than they will from the hay.

ADF

This refers to acid detergent fibre, which consists of cellulose, lignin, bound protein and acid insoluble ash portions of a feed. Since these constituents are indigestible, ADF is a negative indicator of energy level in forages and grains, i.e. as ADF increases, digestible energy is decreased. Early-cut forages contain less ADF and more energy than late-cut forages. Legumes generally have lower ADF and a higher net energy than grasses at comparable stages of maturity.

NDF

Neutral detergent fibre is a measure of hemicellulose, cellulose and lignin content and is used to predict feed intake in ruminants. As plants mature their stem becomes more fibrous, largely due to increasing lignin content, and the NDF levels increase. A low NDF is desirable.

DE

Digestible energy is the amount of energy available to the animal. It is measured as the difference between the gross energy (total amount of energy in the feedstuff) and the energy loss via faeces. Gross energy is determined by measuring the amount of heat produced when a sample of feed is completely burned in a bomb calorimeter in a laboratory.

Minerals

The feed analysis will list the mineral content of the feed.

Other terms

- DMI – dry matter intake, an estimate of the amount of forage an animal will eat and is determined from the NDF content.
- DDM – an estimate of the percentage of the forage that is digestible. It is based on feeding trials and is determined from the ADF content.
- EB, ER – synonymous terms, energy balance or energy retention.

Table 7.4 Average nutrient value of fodder varieties

Feed	Digestible matter (%)	Organic matter (%)	Acid detergent fibre (%)	Digestible dry matter (%)	Crude protein (%)	Metabolisable energy (MJ/kg)
Barley: *Hordeum vulgare*	79.59	93.72	16.34	75.42	12.59	11.31
Burr medic	17.04	88.87	25.90	73.17	26.00	10.98
Canola	34.59		28.50	65.42	12.64	9.81
Chickpea: *Cicer arietinum*	90.97	96.55	10.23	85.47	24.53	12.82
Clover: *Trifolium* spp.	89.26	88.94	26.54	66.60	15.54	9.99
Cowpea: *Vigna sinensis*	90.90	95.74	31.89	64.10	16.16	9.62
Guinea grass: *Panicum maximun*[1]	30.66	Not given	30.39	65.35	16.19	9.80
Johnson grass: *Sorghum halepense*	35.00	89.21	48.56	46.47	6.88	6.97
Lucerne: *Medicago sativa*	76.21	90.64	36.17	61.38	18.05	9.21
Maize: *Zea mays* (as fodder)	33.51	95.22	30.75	61.59	7.96	9.24
Mitchell grass	58.39	92.16	45.39	50.05	9.18	7.51
Oats: *Avena sativa*	55.04	89.71	32.83	63.19	15.84	9.48
Pangola grass: *Digiteria decumens*[1]	90.49	Not given	47.19	45.87	2.75	6.88
Panic	Not given	Not given	35.15	58.49	9.25	8.77
Paspalum	30.72	90.44	44.44	50.54	8.48	7.58
Phalaris	40.70	89.09	33.15	61.96	13.52	9.29
Peanut: *Arachis hypogaea* (as fodder)	91.71	93.41	43.88	53.48	14.39	8.02
Purple pigeon grass	34.73	86.85	45.17	49.59	7.66	7.44
Queensland bluegrass[1]	93.12	94.10	54.29	39.68	1.94	5.95
Red clover: *Trifolium pratense*	83.87	89.81	35.13	61.60	16.55	9.24
Rhodes grass: *Chloris gayana*	46.87	91.52	43.37	50.93	7.33	7.64
Rye grass: *Lolium perenne*	29.48	89.16	30.51	65.28	16.26	9.79
Rye: *Secale cereale* (as fodder)[1]	Not given	90.22	37.76	59.36	16.38	8.90
Spear grass	70.55	92.82	45.23	49.10	6.60	7.36
Subclover: *Trifolium subterraneum*	79.11	88.03	29.99	66.50	18.14	9.97
Triticale (as fodder)	92.76	94.17	39.29	53.15	4.60	7.97

[1] Results of one test only. Source: NSW Agriculture (2003).

- NE – net energy. The value of a feed (MJ/kg DM) is the increase in ER promoted by an increment in the intake of that feed (Standing Committee 1990).
- TDN – total digestible nutrients.
- TP – total protein.

The figures in Tables 7.3 and 7.4 are the averages of a number of tests carried out on each type of feed. Nutrient values vary considerably from one season to the next or from one area to another. Most of the figures quoted are available on the Department of Agriculture (NSW) website, which has an excellent database listing the nutrient values for

hundreds of different feeds from cake mix to wattle, invaluable for people trying to calculate and formulate feed for their livestock. We found it especially useful when searching for suitable alternative feed for our goats during the drought of 2002–03.

Software allows producers and feed merchants to formulate rations without difficulty. Using such a program, the producer can enter the feed type and/or feed analysis results and the program will calculate the nutrient values in a few moments. These programs are excellent but are quite expensive. If you are running no more than a few hundred breeders, it is better to have goat ration or supplementary feed formulated by the nutritionists employed by your feed merchant. They are trained professionals who work in consultation with you to formulate the best feed for your requirements, usually at the lowest cost per tonne.

Three things should be taken into consideration when creating a formula for goat rations:

- availability – this will vary with season and location;
- cost – often depends upon season, availability, type (whether it is straight grain or a processed feed such as lucerne or ration pellets) and cost of transport. Cost also depends on the amount of protein per tonne: usually the higher the protein level, the higher the cost per feed tonne;
- purpose – the class of stock determines such things as the CP, ME, mineral level etc. of the formula.

Table 7.5 is a guide to the nutrition required by each class of stock depending upon age, breeding status, climate and so on.

Vitamins

Goats require vitamins A, B12, C, D and E.

To gain vitamin A, goats' bodies convert carotene found in greenfeed. Excess is stored in the liver.

Vitamin B12 (cobalamin, also known as cobalt) is required for the synthesis of B12. Lack of cobalamin will result in very poor kid growth rates and a rough coat. We frequently give kids an injection of B12 at six weeks of age and inject any goat which has been ill or off its feed.

Unlike humans, who must obtain their vitamin C from food sources, the liver of an adult goat makes approximately 10 000 mg of vitamin C per day so in normal circumstances there should be no need to give supplements. Certain conditions, such as poisoning, may affect the liver and interfere with the production of vitamin C. In such cases, an injection of vitamin C could prove beneficial, but these injections are extremely painful and sometimes cause an abscess to form at the injection site. Therefore, vitamin C injections should be given only when strictly necessary and not as a part of routine husbandry.

Unless your goats are confined to sheds – not usual with meat goats – they will synthesise vitamin D when exposed to sunlight. Kids not receiving adequate vitamin D from exposure to sunlight will develop rickets, just as human children do. Good-quality hay contains adequate levels of vitamin D. If you are feedlotting goats in sheds that do not have artificial daylight, it will be necessary to give them supplements containing vitamin D, such as DCP. Ask your feed formulator or vet about the quantity needed. Most feed contains

Table 7.5 Daily nutrient requirements

Body weight (kg)	Feed energy				Crude protein						Dry matter per animal			
											1 kg = 2.0 Mcal ME		1 kg = 2.4 Mcal ME	
	TDN (g)	DE (Mcal)	ME (Mcal)	NE (Mcal)	TP (g)	DP (g)	Ca (g)	P (g)	Vitamin A (1000 IU)	Vitamin D (IU)	Total (kg)	% of kg BW	Total (kg)	% of kg BW
Maintenance only (includes stable feeding conditions, minimal activity, early pregnancy)														
10	159	0.70	0.57	0.32	22	15	1	0.7	0.4	84	0.28	2.8	0.24	2.4
20	267	1.18	0.96	0.54	38	26	1	0.7	0.7	144	0.48	2.4	.40	2.0
30	362	1.59	1.30	0.73	51	35	2	1.4	0.9	195	0.65	2.2	0.54	1.8
40	448	1.98	1.61	0.91	63	43	2	1.4	1.2	243	0.81	2.0	0.67	1.7
50	530	2.34	1.91	1.08	75	51	3	2.1	1.4	285	0.95	1.9	0.79	1.6
60	608	2.68	2.19	1.23	86	59	3	2.1	1.5	327	1.09	1.8	0.91	1.5
70	682	3.01	2.45	1.38	96	66	4	2.8	1.8	369	1.23	1.8	1.02	1.5
80	754	3.32	2.71	1.53	106	73	4	2.8	2.0	4.8	1.36	1.7	1.13	1.4
90	824	3.63	2.96	1.67	116	80	4	2.8	2.2	444	1.48	1.6	1.23	1.4
100	891	3.93	3.21	1.81	126	86	5	3.5	2.4	480	1.60	1.6	1.34	1.3
Maintenance plus low activity (25% increment, intensive management, tropical range, early pregnancy)														
10	199	0.87	0.71	0.40	27	19	1	0.7	0.5	108	0.36	3.6	0.30	3.0
20	334	1.47	1.20	0.68	46	32	2	1.4	0.9	180	0.60	3.0	0.50	2.5
30	452	1.99	1.62	0.92	62	43	2	1.4	1.2	243	0.81	2.7	0.67	2.2
40	560	2.47	2.02	1.14	77	54	3	2.1	1.5	303	1.01	2.5	0.84	2.1
50	662	2.92	2.38	1.34	91	63	4	2.8	1.8	357	1.19	2.4	0.99	2.0
60	760	3.35	2.73	1.54	1.5	73	4	2.8	2.0	4.8	1.36	2.3	1.14	1.9
70	852	3.76	3.07	1.73	118	82	5	3.5	2.3	462	1.54	2.2	1.28	1.8
80	942	4.16	3.39	1.91	130	90	5	3.5	2.6	510	1.70	2.1	1.41	1.8
90	1030	4.54	3.70	2.09	142	99	6	4.2	2.8	555	1.85	2.1	1.54	1.7
100	1114	4.91	4.01	2.26	153	107	6	4.2	3.0	600	2.00	2.0	1.67	1.7
Maintenance plus medium activity (50% increment, semi-arid rangeland, slightly hilly pasture, early pregnancy)														
10	239	1.05	0.86	0.48	33	23	1	0.7	0.6	129	0.43	4.3	0.36	3.6
20	400	1.77	1.44	0.81	55	38	2	1.4	1.1	216	0.72	2.6	0.69	3.0
30	543	2.38	1.95	1.10	74	52	3	2.1	1.15	294	0.98	3.3	0.81	2.7
40	672	2.97	2.42	1.36	93	64	4	2.8	1.8	363	1.21	3.0	1.01	2.5

Table 7.5 Daily nutrient requirements (Continued)

Body weight (kg)	Feed energy				Crude protein						Dry matter per animal			
											1 kg = 2.0 Mcal ME		1 kg = 2.4 Mcal ME	
	TDN (g)	DE (Mcal)	ME (Mcal)	NE (Mcal)	TP (g)	DP (g)	Ca (g)	P (g)	Vitamin A (1000 IU)	Vitamin D (IU)	Total (kg)	% of kg BW	Total (kg)	% of kg BW
50	795	3.51	2.86	1.62	11o	76	4	2.8	2.1	429	1.43	2.9	1.19	2.4
60	912	4.02	3.28	1.84	126	87	5	3.5	2.5	492	1.64	2.7	1.37	2.3
70	1023	4.52	3.68	2.07	141	98	6	4.2	2.8	552	1.84	2.6	1.53	2.2
80	1131	4.98	4.06	2.30	156	108	6	4.2	3.0	609	2.03	2.5	1.69	2.1
90	1236	5.44	4.44	2.50	170	118	7	4.9	3.3	666	2.22	2.5	1.85	2.0
100	1336	5.90	4.82	2.72	184	128	7	4.9	3.6	723	2.41	2.4	2.01	2.0
Maintenance plus high activity (75% increment, arid rangeland, sparse vegetation, mountainous pastures, early pregnancy)														
10	278	1.22	1.00	0.56	38	26	2	1.4	0.8	150	0.50	5.0	0.42	4.2
20	467	2.06	1.68	0.94	64	45	2	1.4	1.3	252	0.84	4.2	0.70	3.5
30	634	2.78	2.28	1.28	87	50	3	2.1	1.7	342	1.14	3.8	0.95	3.2
40	784	3.46	2.82	1.59	108	75	4	2.8	2.1	423	1.41	3.5	1.18	3.0
50	928	4.10	3.34	1.89	128	89	5	3.5	2.5	501	1.67	3.3	1.39	2.7
60	1064	4.69	3.83	2.15	146	102	6	4.2	2.9	576	1.92	3.2	1.60	2.7
70	1194	5.27	4.29	2.42	165	114	6	4.2	3.2	642	2.14	3.0	1.79	2.6
80	1320	5.81	4.74	2.68	182	126	7	4.9	3.6	711	2.37	3.0	1.98	2.5
90	1442	6.35	5.18	2.92	198	138	8	5.6	3.9	777	2.59	2.9	2.16	2.4
100	1559	6.88	5.62	3.17	215	150	8	5.6	4.2	843	2.81	2.8	2.34	2.3
Additional requirements for late pregnancy (all goat sizes)														
	397	1.74	1.42	0.80	82	57	2	1.4	1.1	213	0.71		0.59	
Additional requirements for growth – weight gain at 50 g per day (all goat sizes)														
	100	0.44	0.36	0.20	14	10	1	0.7	0.3	54	0.18		0.15	
Additional requirements for growth – weight gain at 100 g per day (all goat sizes)														
	200	0.88	0.72	0.40	28	20	1	0.7	0.5	108	0.36		0.30	
Additional requirements for growth – weight gain at 150 g per day (all goat sizes)														
	300	1.32	1.08	0.60	42	30	2	1.4	0.8	162	0.54		0.45	

Note: Tables reproduced with the permission of the US Board of Agricultural & Renewable Resources and Subcommittee on Goat Nutrition (1992).

some vitamin D but goats confined away from natural daylight may need more than the level normally included in goat mash or feed, whose formulas assume that goats are normally exposed to sunlight.

Vitamin E is an antioxidant and low vitamin E is often associated with a selenium deficiency (Australian soils are often deficient in selenium).

We often give a combined vitamin A/D/E injectable preparation to kids at weaning time, particularly in drought years when their mothers may not receive enough nutrition to give their kids sufficient vitamins A and E. If kids are lacking any of these vitamins, the results within 10 days of receiving the injection are obvious. An improved coat is the first thing, quickly followed by an increase in growth, appetite and energy.

Minerals

Goats require several different minerals, notably calcium, phosphorus, dolomite, iron, iodine, selenium and copper.

Calcium

A deficiency of calcium (Ca) in the kids' diet will slow growth and, if extreme, cause rickets. If kids are receiving sufficient milk from their mothers this should not be a problem. In adults, lack of calcium can cause many problems, some of them serious, for example hypocalcaemia. Calcium is discussed in more detail in the following paragraphs on phosphorus.

Phosphorus

Phosphorus (P) is required for tissue and bone growth; deficiency will result in slow growth and an unthrifty appearance. Phosphorus deficiency is common among stock in some regions of Australia, such as mulga country. Advice on the status of your area is available from the Department of Primary Industries or Agriculture extension officers. A soil test should be done if you suspect that your pastures are short of phosphorus, as soils can differ even within a local area.

The phosphorus content of plants decreases with maturity because the mineral is continuously transferred to new growth. There is less likelihood of a deficiency in temperate regions than in tropical regions. Tropical forages have a lower P content (Watson and Norton 1982) because soils are often low in phosphate, the use of fertilisers is often uneconomic and the forages mature and senesce (hay off) more rapidly than temperate species.

The introduction of more productive plants that can tolerate low soil phosphates, such as *Styloanthes* spp., may compound the problem because realisation of the potential increase in animal production requires an increase in goats' phosphorus intake.

Calcium and phosphorus are the two most plentiful minerals in a mammalian body. There is about 400 g of calcium and 220 g of phosphorus in the skeleton and teeth of a 40 kg sheep and about 6 kg Ca and 3.2 kg P in the skeleton and teeth of a 500 kg cow. These quantities are about 0.99 and 0.80, respectively, of the total amounts in the body. The remaining phosphorus is present in body cells where it is involved in maintaining cell integrity and in intracellular energy and protein metabolism. Only small quantities of Ca and P are present in extracellular fluids, but goats' salivary glands concentrate phosphorus in their copious secretions and so there is substantial recycling of the mineral.

Table 7.6 Ca and P requirements

Kids			Adults		
Live weight	**Ca (g)**	**P (g)**	**Live weight**	**CA (g)**	**P (g)**
15 kg	2.0	1.2	40 kg	2.5	1.2
20 kg	2.4	1.4	50 kg	2.7	1.4
25 kg	2.6	1.5			

The skeleton provides an enormous reserve of Ca and P, which can be drawn on during periods of dietary deficiency. This makes estimating the dietary requirements of adult, non-pregnant, non-lactating goats particularly difficult because mineral deficiencies may not be obvious for quite a while (Standing Committee 1990). You may, however, notice that the goats eat less. It also appears normal for the mothers to have a negative Ca and P balance early in lactation.

Dolomite

Our goats have dolomite available ad lib, except during the final few weeks of pregnancy when we remove it so that the does will begin to mobilise calcium from their bones, which helps prevent hypocalcaemia. The does need to be slightly Ca-negative during this time. When the does have kidded we again provide dolomite ad lib. Before we started the practice of removing dolomite, several does each season suffered from hypocalcaemia (milk fever) and some of them died despite treatment.

Dolomite consists mainly of 14% Ca (available nutrient) from 35% $CaCO_3$ (calcium carbonate) and 8% magnesium (available nutrient) from 33% $MgCO_3$ (magnesium carbonate).

Estimates of goats' average daily dietary requirements of Ca and P from all sources are given in Table 7.6.

Cattle deficient in phosphorus often chew the bones of dead stock and sometimes die from botulism contracted from the bones. Dead livestock should be disposed of by burning or burying. We have not seen goats bone-chewing, but believe that if they have a severe phosphorus deficit they may, and could suffer the same consequences as cattle. The problem of bone-chewing usually occurs in very dry or drought periods when there is little or no fresh feed available.

Iron

In drought years, goats may not receive enough iron (Fe) from their feed in the paddock. The does, especially when pregnant or lactating, should receive a mineral and vitamin supplement. This is usually given in the form of 'lick blocks' available from feed stores.

Iodine

Iodine (I) deficiency can cause a number of serious problems in kids; if a doe's diet is poor in iodine during pregnancy it can result in weak or dead kids. Older kids may have a swelling on their throat, due to an enlarged thyroid gland. Swelling in the front of the throat occurs more often in young buck kids that are growing so quickly that their thyroid is forced to work very hard to keep up with the production of thyroxine. Don't confuse this with the swelling under the chin that is caused by Barbers Pole worm.

Among our buck kids it is always the largest and fastest-growing that develop an enlarged thyroid gland. It seems that giving extra iodine is of no benefit. The swelling will

subside spontaneously when the young buck's growth begins to slow and the thyroid is able to catch up. The problem always resolves itself by the time the bucks reach six months of age. We have not observed this condition in young does.

Selenium

Selenium (Se) and vitamin E deficiencies go hand-in-hand – where you have one, you usually have the other. Deficiency of selenium can cause white muscle disease in kids. In serious deficiencies, death may result. Acid soils and high-rainfall areas can predispose to soil deficiency of selenium. This problem is so common that sheep drenches containing selenium are now available. Information on regional soil types and how to correct deficiencies in farm soil is available from state Departments of Primary Industry or Agriculture.

Copper

The amount of copper (Cu) goats need is hotly debated, because the copper available from pasture, feed or supplements is influenced by several other components in the goats' diet. Minerals such as molybdenum, sulphur, zinc, iron, cadmium and some organic constituents of a goat's diet affect the availability of copper. Because the interactions of these components are so complex, an exact dietary level is difficult to establish. There have been many studies of Cu levels in sheep and cattle, including the toxic levels of intake.

Copper and molybdenum are interrelated in the metabolism and should be considered together (Hennig et al. 1974). Levels of both can be too low or too high, or the level of one can be low and the other too high.

The most common problem occurs when a normal or low level of copper is accompanied by a high level of molybdenum. Copper is excreted and deficiency occurs. This condition can be corrected with copper therapy: professional advice should be sought.

Sheep are less tolerant of high levels of dietary copper than cattle. While it is believed that goats have a higher tolerance level for copper than other domestic stock, many goats have been poisoned by it. Poisoning is either inadvertent, or results from a breeder following the advice of another breeder (who has been supplementing their stock with copper) and supplementing their own stock without knowing their actual copper status. The poisoning can also be due secondary phytogenic (plant) poisoning from ingestion of plants containing pyrrolizidine alkaloids.

An amount of copper supplementation that is correct on one property may not be correct on another because of the variations in soil, pasture and conditions even on properties that are quite close to each other. On any given property, soil types can vary considerably from one area to another. The mineral content of the differing soil types greatly influences goats' intake and retention of copper.

If copper toxicity or deficiency is suspected and the cause is unknown, a soil test should be carried out so that any imbalance of copper or other minerals in soil and/or pasture can be corrected. Tests that establish copper-dependent activities in the blood and copper concentrations in the liver can determine if there is a problem, and should be done at the same time as the soil tests. Your vet can arrange this.

A US study on the effect of dietary copper on the copper status of lactating does and their kids evaluated the effect of feeding free-choice minerals containing three levels of dietary copper. We include an abstract, reproduced with permission (Luginbuhl et al. 2000).

Fifty-one pregnant does (BW 56 kg) were separated into six equal groups six weeks prior to kidding, assigned three experimental treatments (free-choice minerals) containing either zero, 1000 or 3000 mg Cu/kg DM) and pen-fed hay and a grain mix for four weeks. Goats were then grazed on three separate perennial pastures starting two weeks before the kidding season (21 March–17 April) until weaning on 8 July. The intake of free-choice minerals by pregnant and lactating does was monitored weekly throughout the trial. Blood samples for the determination of plasma Cu were taken by from 24 does at the start of the trial, and from the same does and 15 kids at weaning. Kids were harvested (slaughtered) at weaning and liver samples taken for the determination of liver Cu concentrations. From the start of the trial until the end of kidding, does consumed daily 22.3, 20.1 and 20.9 free-choice minerals, corresponding to respective Cu intakes of 0.0, 20.1 and 62.6 mg/d. Does with nursing kids consumed 22.4, 23.4 and 65.7 mg/d respectively. Blood plasma Cu of does at the start of the trial (average 1.37 mg/L) and at weaning (average 1.27 mg/L), and of kids at weaning (average 1.15 mg/L), was not affected by treatment. Kid birth weight (average 3.6 kg), weaning weight (average 20.5 kg), daily weight gain from birth to weaning (average 160 g/d), live and carcass grade at weaning (average 1.2, USDA scale), carcass weight (average 10.2 kg) and carcass yield (average 49.6%) were not affected by treatment.

Liver concentrations increased linearly ($P < .01$) with increased dietary Cu (110, 182, 247 mg/kg DM, respectively) but liver lesions were minimal and not affected by addition of Cu. Feeding these levels of Cu for six months were not detrimental to does or their kids and did not affect kid performance.

Signs of copper deficiency

The following are some of the signs of copper deficiency in stock:

- loss of colour in the coat – there is a copper-containing enzyme which is necessary for melanin production. Copper-deficient cattle often have light-coloured circles around their eyes;
- anaemia occurs because ceruloplasmin is required to mobilise stored iron for synthesis of haemoglobin and myoglobin;
- swayback and enzootic ataxia in kids are related to demyelination;
- cardiac insufficiency, which is probably due to a combination of problems including inadequate cytochrome oxidase activity and anaemia;
- osteoporosis and spontaneous bone fractures related to effects of copper-related enzymes;
- abortions and stillbirths.

Copper toxicity

Goats are not as susceptible to copper toxicity as sheep. A deficiency of molybdenum (less than 0.1 ppm) does not usually induce copper toxicity but it does interfere with normal growth and fertility. Young kids are more sensitive to increased copper levels in feed than adults are.

Reports of naturally occurring copper poisoning in goats are rare. Poisoning usually happens when goats are given access to pastures with pyrrolizidine alkaloid-containing plants, which promote the accumulation of copper in the liver even when dietary levels of Cu are within normal limits. The effects of eating these plants are long-term and cumulative. It may take two or three seasons for animals grazing on pyrrolizidine alkaloid-containing plants to show signs of massive liver damage, and for stock losses to begin.

There are approximately 160 known pyrrolizidine alkaloids in plants. Pyrrolizidine alkaloids cause the direct death of cells (particularly in the liver), stop cells dividing to replace those lost through normal attrition, and damage blood vessels. The main organ targeted is the liver, but other organs including the kidneys and lungs may be damaged (McKenzie 1996).

In secondary phytogenous (plant) poisoning, there are several species that seem to be implicated most often. These are subterranean clover (*Trifolium subterraneum*), blue heliotrope (*Heliotropium amplexicaule*), Patersons curse (*Euchium plantagineum*), rattlepods (*Crotalaria* spp.), fireweed (*Senecio* spp.), ragwort (*Senecio* spp.) and groundsels (*Senecio* spp.). Because of the long-term damage caused to stock ingesting these plants, remove them from your pastures if possible or at least restrict access to them.

Many cases of copper poisoning are attributable to an overdose of copper sulphate given by well-intentioned owners who mistakenly believe that if a little bit of something is good, then more must be better. There have also been cases of poisoning due to stock gaining access to pig feed, which has a high Cu content.

Daily copper requirements

According to Lamand (1981), 7 mg Cu/kg diet DM is considered the deficiency limit for goats. The same author recommended 10–14 mg/kg dietary DM as suitable Cu levels for ration formulation, the higher levels being a precaution against interference from other minerals such as molybdenum (Mo), sulphur and iron (Spears 1995). Guegen et al. (1988) reported that 7–10 mg Cu/kg dietary DM was adequate and indicated that diets containing over 3 mg/Mo/kg dietary DM should be avoided.

Copper concentrations in a ration strongly depend on copper absorption. Chapman and Bell (1963) ranked inorganic forms of copper in decreasing order of availability as $CuCO_3$, $Cu(NO_3)_2$, $CuSO_4$, $CuCl_2$, Cu_2CO, CuO (needles) and Cu (wire).

Sources for this section were Haenlein et al. (1981), Kessler (1991), Haenlein (1987), Luginbuhl and Poore (1992), Petersen (1995), Smith and Sherman (1994), Standing Committee (1990), McKenzie (1996), Luginbuhl et al. (2000), Martin (2003), Agriculture, Food & Rural Development (2003).

Using goats for weed control

Because goats are browsing animals they are very cost- and time-efficient in controlling noxious weeds such as blackberry and prickly acacia and have been used for this purpose in some areas of Victoria and New South Wales where there were large infestations of blackberries on a property. There are a number of advantages in using goats for pest plant control. They are more cost-effective than spraying and ripping, they can be sold when no longer needed and they are much more environmentally friendly than poison. Goats

control weeds by preventing them from flowering and dispersing seed, ringbarking or structurally weakening some shrub species and by preferentially grazing some species and so placing them at a disadvantage (Allan, Holst and Campbell 1999; McKenzie 1996).

The cost in time and money normally needed to control blackberry is enormous and usually not very effective. Millions of dollars have been spent but blackberries are still a problem to producers and farmers in the southern states.

Around Longreach in western Queensland, prickly acacia (*Acacia nolitica*) and gidyea (*Acacia cambagei*) are a major problem for cattle and sheep producers. In north and central-western Queensland there are an estimated 6.5 million ha of prickly acacia infestation, 38% of it is beyond individual property control. It was introduced in the 1890s from the Middle East as shade and fodder and was planted along bore drains and watering points. It was declared a noxious weed in 1957.

Gidyea is native to Australia and control of regrowth, that covers an estimated 5.8 million ha in Queensland and New South Wales, was estimated to cost $1520 per ha. Regrowth must be pulled out every 10–15 years (Felton and Cobon 1998). Goats are definitely a more economical alternative than the pulling or poisoning needed to control this pest.

When using goats for weed control a high stocking rate is necessary because goats naturally prefer the tastier species in the paddock, so must be forced to eat the weeds through lack of alternatives. The area in which the goats are to be confined must be small and/or greatly overstocked. In the case of blackberry, for instance, the recommended stocking rate is 30 goats per hectare. Once goats have eaten the plants and pasture that they prefer, they will be driven by hunger to eat the target species of weeds. It is necessary to check now and then that goats have not run out of feed, so that they do not starve to death.

8

Drought feeding and strategies

Australia is the driest continent on earth. Unfortunately, knowing that and dealing with it are two different things. Many farmers and graziers are driven to despair and or bankruptcy during drought. It is a difficult thing to see pasture turn to dust and the stock that you may have spent many years building into a fine herd, starting to die. Drought is a fact of life in Australia and careful forward planning can help to mitigate some of its effects, if not eliminate them.

Most droughts come in cycles and long-range weather forecasts from the Australian Bureau of Meteorology can help you decide when a drought may be on the way. You can also check local rainfall records to see when a drought could be expected in your area. Keeping your own rain records over several years is also useful because rainfall can vary considerably within a few kilometres: the rainfall recorded in your local town can be very different from that received on your property. Some useful software programs for establishing rainfall patterns are:

- Australian Rainman®
  CB Alexander Agricultural College, Tocal
  Paterson NSW 2421
  Phone 1800 025 520
  Fax (02) 4938 5549
- MetAccess®
  Horizon Technology Pty Ltd
  PO Box 598
  Roseville NSW 2069
  Phone (02) 9805 1941
  Fax (02) 9887 4428

If it appears that a drought may be coming, you must decide the point at which you will consider that your property is actually in drought. This will be different for each producer and each area. Some parts of the arid inland may not be considered in drought unless there is no rain in a 12-month period, while coastal producers might consider themselves to be in drought if no rain is received for three months. Drought and the definition of it are fairly individual, but a good definition is 'Drought exists when rainfall is insufficient for normal farming practices to be carried out' (Markwick 2002). The reality for producers, however, is much harsher than that definition. When there is no feed in the paddock and the stock have to be shot before they die of starvation, you know that you are in drought!

If it hasn't rained for weeks but there is still ample pasture and water, you would not consider yourself to be in drought. However, if it doesn't rain for several months or more, pasture is less than 2 cm high and the dams are almost empty, you would consider yourself in drought.

If your goats come home in the evening looking as if they are wearing black lipstick it is more than time to have a close look at the pasture. In fact, if goats have dirt all over their mouths the pasture should have been monitored weeks before and a supplementary feeding program begun. Pasture that has been eaten down below 2 cm often won't recover and must be resown after the drought breaks. In addition, if there are no roots left to protect and hold the soil there will be erosion and loss of topsoil.

In a drought, the nutrient in shortest supply is energy, which should be supplied if possible as grain or good-quality hay. If the stock are fed a very low-quality fodder, such as sugarcane tops which have very little nutrient value and consist mainly of silica, goats will still lose weight rapidly even if they are given ad lib access. On such a diet, they will die of starvation if there is no other source of feed.

Once stock have begun to lose condition due to lack of feed it is hard to arrest the trend. There is a critical weight for each class of stock below which serious problems begin and the weak, the old or the very young will die. If an animal loses more than 50% of its bodyweight it is very difficult to stabilise it, reverse the weight loss and (if it survives) regain weight. Once an animal drops below critical live weight it will be too weak to travel far enough from water to find sufficient food and return to the water to drink. The very young and the old usually do not recover once they have lost more than 50% of their bodyweight. Young growing goats and kids become stunted (just as human children do) and won't reach their full potential if they are severely deprived of energy and protein when young.

A method for determining critical live weight for your herd (because each herd is different) is to use a weight 30% less than the recent peak live weight, plus 1 kg for each year of age, plus estimated fleece weight (McGregor 2002). Critical live weights of goats depend on age and breed, but Table 8.1 may be used as a guide.

There are several strategies for dealing with drought: forward planning, destocking, breeding issues and alternative feeds.

Forward planning involves various aspects:

- put in more dams;
- buy hay when it's cheap;
- decide ahead of time on the signal that will make you put your drought plan into action, e.g. lack of rain, short pasture, loss of stock condition;

Table 8.1 Critical live weights

Breed	Critical weight
Adult feral and Angora	30 kg
One-year-old feral and Angora	20 kg
Two-year-old feral and Angora	25 kg
Adult dairy-type goats	35 kg
South African Boer does	35 kg
South African Boer bucks	50 kg

Source: Scarlett and Carberry (2001); McGregor and Attwood (2003).

- make a plan of action for dealing with drought when the criteria are reached;
- set your credit limit.
- find out what drought assistance is available if you should need it.

Destocking involves:

- selling surplus stock'
- culling old or undersized goats and poor breeders etc.;
- agistment – sending stock to better pasture elsewhere;
- early weaning and/or selling kids.

Breeding issues are:

- whether the stock should be joined;
- if so, which stock you should join.

Alternative feed means:

- cutting native shrubs and trees for fodder – permits are required;
- using feeds not normally considered, e.g. banana palms and citrus peel.

Forward planning

Water is the major consideration in a dry continent. If there is no water on a property from whatever source is normal for the area, for example bores in the inland or dams and rivers nearer the coast, there is a serious problem. The time to put in that new dam or put down that extra bore was yesterday! Of course, this involves a large amount of capital but putting in extra water storage for future needs should be considered. If we had not put in new dams when we bought our property, we would have spent about $32 000 buying water during the last five years of drought. The dams cost us much less than that.

Before you put in new dams or bores, you must check the regulations involved. They are different in each state and territory and the penalties for breaching regulations can be severe.

Buy fodder when it's cheaper

In early autumn, fodder is usually cheaper than later in the year and of better quality with higher protein levels etc. A square bale of irrigated lucerne hay costs around $5.50 in late summer in south-east Queensland; the same hay in winter can cost over $16 a bale. Try to

buy it locally to limit your transport costs. Most states have an online fodder registry which can be accessed through Department of Agriculture or Primary Industries website.

Be cautious when buying fodder, especially if it is very cheap. Some people, cashing in on the drought and producers' desperate need for feed, will bale and sell anything. One inexperienced producer bought 500 bales of grass hay at $2.50 per bale, which turned out to be mostly giant rats tail grass. This is a declared Class 2 weed and mature giant rats tail grass consists mainly of indigestible silica. Cattle fed on it will starve to death despite having full stomachs. Giant rats tail grass is also very difficult and expensive to eradicate: the unfortunate producer who bought it is still trying to eradicate it five years later and has so far spent approximately $45 000 on the problem. If you buy hay from an area unknown to you, find out first if the area is known for pest plants, such as parthenium weed. It is better to err on the side of caution than to end up with a paddock full of giant rats tail, parthenium weed or other pest plant.

Suppliers are legally required to give you a weed hygiene declaration or other written notice before supplying anything contaminated with the following Class 2 weeds: parthenium (*Parthenium hystophorus*); prickly acacia (*Acacia nilotica*), giant rats tail grass (*Sporabolus pyramidalis*), American giant rats tail (*S. jacquemontii, S. natalensis*), giant Parramatta grass (*S. fertilis*) and Parramatta grass (*S. africanus*).

In Queensland, you can ask the supplier for a weed hygiene declaration before you purchase fodder, chicken feed, soil or anything else that is, or could be, contaminated with weeds. Forms are available (in Queensland) from the Department of Natural Resources and Mines, Agforce and the NR& M website: www.nrm.qld.gov.au/pests/weedseed/index.html

Weeds cost Queenslanders $500 million annually in lost production and control, and the figures would certainly be comparable in other states. For this reason there are penalties for knowingly supplying, selling or transporting any weed or product that may be contaminated with a Class 1 or Class 2 weed. Check with the Agriculture or Primary Industries Department for a list of declared weeds, and current regulations.

Drought criteria

Decide ahead of time on the criteria that will trigger your drought plan. This will probably be one of the following.

1. Failure of rainfall over a significant period during which rain is normally expected. South-east Queensland normally experiences spring rain; if it fails completely in a given year and there is still no rain by early summer then, if you have native pasture, you will probably decide that you are in drought.

   Most of the pastures in our subtropical region, such as speargrass or forest bluegrass, need spring rain to trigger their new growth. The pasture left in the paddocks after winter is heavily lignified and has very little protein or food value. Stock eating such pasture begin to lose condition.
2. If pasture is less than 2 cm high and is becoming sparse, your stock are going to be in energy deficit. This is a signal for urgent action: weaners will slow or stop their growth; bucks will lose condition; pregnant does can develop pregnancy toxaemia, lose condition and produce small weak kids, lose milk production or abort.

Make a plan of action and try to stick to it, but be flexible because circumstances can change from day to day. You may decide, for instance, that if you have only X amount of pasture or fodder left you will start selling your stock, but a few days later someone offers to agist much of your stock at a reasonable rate. If you know that the feed available in the agistment paddock is good and pest-weed-free, agisting may be a good alternative to selling valuable stock, especially if you would be losing irreplaceable bloodlines or selling at a loss.

Drought assistance

If your shire has been drought-declared, don't be too proud to apply for drought assistance. It can be the lifeline that will save your enterprise. It offers financial assistance with such things as transport of stock to and from agistment, transport of water for stock and so on.

The first step is to contact the Department of Agriculture or Primary Industries. Each state has a drought hotline for information on drought assistance and there is a national drought hotline: 13 26 16.

The federal government's Exceptional Circumstances (EC) package is the primary drought assistance package available to farmers experiencing drought conditions, and as such it provides substantial long-term assistance through interest rate subsidies and income support. It also contains provisions for small business assistance. A map on the AFFA website details EC-declared areas. Contact Centrelink or the National Drought Hotline (13 26 16) for further clarification.

Limit your credit

Decide on your maximum credit limit and don't go beyond it. Consider future changes in interest rates when deciding on your credit limit. If you will only be able to service a maximum debt of $20 000 dollars at 8% p.a. interest and the interest rate rises to 12% p.a., there is going to be a problem. Discuss this with your accountant, bank manager or other financial adviser.

Destocking and agistment

Destocking

Cull the old, undersized and non-thrifty by selling or destroying. It is better to do this as soon as you realise you are going into a period of drought that may last long enough to become a problem. The more stock on the property, the less feed and water is available for each. During a drought you are playing for time and fighting for the survival of your enterprise, and some very difficult decisions must be made.

Sell surplus stock before the market is flooded by other producers doing the same thing.

Wean kids early, at 10–13 kg, and sell as many as possible. This will take some pressure off remaining pasture as dry does need less feed.

Agistment

In Australia, agistment is usually thought of as allowing another producer's stock to graze pasture or crop stubble on your property, for payment. Agistment can be for a short time or as a long-term agreement. If it is going to be for a long period, such as 12 months, there

should be a lease agreement. For example, the owner of the land will be responsible only for providing feed and water and reporting any stock problems such as disease or dog attack.

The cost of agistment is usually negotiated between the parties involved and depends upon whether agistment is readily available or hard to obtain, such as during drought. In a good season, when feed is readily available, you might pay 20c per goat per week but in a drought it could cost more than 50c per week. Add to this the cost of transport, and agistment can become very expensive. However, if non-essential stock have been disposed of you may need to agist only part of the herd to take grazing pressure off your paddocks. In a severe drought the entire remaining stock may need to be agisted, or disposed of if hand-feeding or agistment aren't possible. Restocking can be done after the drought has broken.

Send goats to agistment before their condition becomes too poor, as goats in very poor condition often die during transport, from stress. Give them water as soon as they are unloaded from the transport. If they are fed before they are properly rehydrated, there will be heavy losses.

Before bringing goats back from agistment, make sure your pasture has been growing-on for at least a month. Growth younger than this is mainly water and contains little protein. The protein level rises to an acceptable level approximately six weeks after the first good rains.

When stock are due to be returned from agistment, prepare a holding paddock as you do for all new goats – stock returning from agistment must be isolated in the prepared paddock. As soon as they have been unloaded and had a drink they should be drenched with a broad-spectrum drench to destroy any parasites ingested while agisting. Faecal samples should be taken for testing before you drench your returned stock so you become aware of potential problems.

Feed your returned goats a good-quality hay and grain mix for up to 10 days. This allows any weed seeds they have ingested to pass through. After they have been released, check the paddock, in which they have been confined, from time to time over the following 12 months to make sure that no noxious or pest weeds are emerging.

Hand-feeding

If you decide not to agist your goats, the remaining stock may need to be hand-fed. Selecting the types and amounts of feeds to give goats during drought involves four steps:

1. determining the total energy and protein requirements of each class of goat;
2. determining the protein and energy content of available and suitable feeds;
3. calculating which of the available and suitable fodder is cheapest;
4. calculating the amount and cost of the selected feed.

Separate classes of stock

It is good practice to separate the different classes of stock when you are hand-feeding, for two reasons: it will allow supply of the correct amount of maintenance diet to each group, and it will allow the younger weaners to get their share of the feed without being pushed away by the adults, which tends to happen when they are together. We have seen kids killed when crushed in the stampede to the feed troughs.

Separation of the classes also prevents dry does from injuring pregnant does in the push and shove at the feed trough. There will still be dominant goats that get more than their share of feed and shy feeders that get little, but at least most of the goats will be able to obtain enough nutrition to survive.

It may be necessary to draft the shy feeders into a separate area where they can be fed apart from the main group. Shy and timid goats may comprise 10–20% of the herd (McGregor and Attwood 2003). The problem of shy or timid feeders can have two consequences, one of which is that hungry goats desperate for feed will headbutt and jostle each other – shy animals or those weakened by drought are often injured or killed in the crush, especially if knocked over and trampled. The second problem is that because shy or timid goats are not eating their share of the calculated allowance of feed per goat, other goats may gorge and suffer the consequences of acidosis or bloat.

Grain

If you are feeding grain on the ground, make the grain trails as long as possible. It has been suggested that laying grain out in a circle is better than a straight trail.

When goats have not been used to receiving grain supplements, there will be problems if the full supplement is given at the start of hand-feeding. The grain supplement must be started at 50 g per day per goat. This is increased by 50 g per day until a 35 kg goat is receiving 430 g per day.

It is not advisable to crack or hammer-mill this grain as it is more likely to cause digestive upset in goats if treated, than otherwise. Sodium bentonite should be included in the feed if a large quantity of grain is being fed (Scarlett and Carberry 2001; McGregor 2003).

Breeding issues

Think carefully about whether to join your does during drought. Does in their last few weeks of pregnancy have greater feed requirements, as do lactating does. However, if you do not join stock, how will you generate income next year?

One strategy that we employed during two years of severe drought was not to join the commercial does. Because of the lack of available grazing, they would have had to be fed for the final six weeks of pregnancy and at least three months after kidding, until their kids could be weaned. The cost would have been prohibitive because of the number of does. This decision reduced income from the commercial herd to zero for the next year. However, we decided to join our full-blood South African does, because we have far fewer of them. The cost of feed would be less and the offspring would be more valuable than the commercial kids.

The decision was difficult and the consequences far from ideal, but it had to be made for the long-term survival of the enterprise and the physical survival of the commercial herd that we could not afford to feed. Whether the decision was a good one remains to be seen, but hopefully the damage to both the animals and the little remaining pasture was limited.

Alternative feed

When pasture hay and grain are scarce, other feeds can be used which would not normally be considered suitable. Although not ideal, they will keep your goats alive until better feed is

available. An excellent website belonging to the Department of Agriculture (NSW) has an interactive database that lists many conventional and unconventional feeds. It is definitely worth a visit: http://www.agric.nsw.gov.au/feedbase.

Consider using straw or crop stubble to save on feed costs. These have a low energy value, however, so cannot be sole feed source. As with sugarcane tops, stock may have a full stomach of this low-grade feed but continue to lose weight and die of starvation. This is because straw and stubble contain less than 7 MJ/kg, which is less than maintenance level for your goats. They will provide ruminal scratch (roughage) at the same time as providing some energy. The energy deficit can be topped up with grain etc. Grain is more expensive than straw, so replacing up to 50% of the grain supplement with straw means substantial savings.

The protein content of poor-quality hay and straw can be raised by treating the bales with the following mixture, originally developed for feeding cattle during drought. The Department of Primary Industries (Qld) states that this type of treated hay or straw would be eaten by goats at a rate of 1–1.5% of bodyweight per day. If treated hay were the only source of supplement a 40 kg doe would daily consume approximately 600 g of it, which would supply approximately 4.8 g of urea. As the safe level of daily intake of urea for goats is 10 g, feeding this hay to goats should not cause any problems (Tyler 1993; Mills 2003).

Protein recipe

9 kg urea
45 L hot water (not boiling)
13 L molasses

Urea and molasses dissolve more readily in water that is hot, not boiling. One litre of this mixture contains 150 g of urea, which is enough to treat a 20 kg bale. **Never** feed this mixture directly to your goats, as it will almost certainly kill them.

To treat a bale, stand it on its side with cut ends upwards, cut the top string and pour 1 L of the mixture evenly over the surface of the bale. Round bales can be treated by pumping the mixture into the bale with a spear.

Let the treated bales stand for 12–24 hours before feeding out. Leaving the hay to stand allows the mixture to disperse more evenly through the bales.

Many factories that process grains or fruits produce waste products that are normally discarded as landfill. They are often only too happy to give this waste product or residue to graziers at little or no charge because they can save themselves the cost of disposing of it. Waste products may consist of such things as citrus pulp and peel from juice factories, broken wheat breakfast-cereal biscuits, stale bread (too much may cause bloat), tomatoes rejected for size or colour etc., banana palms cut after harvesting their fruit and so on.

When feeding alternative feed such as tomatoes and fruits, check what sprays, fertilisers and poisons may have been used in connection with the crop.

SAFEMEAT spokesperson David Palmer (2002) said 'Chemically treated cotton trash, sugarcane and corn trash are just some examples of feeds which should not be fed to livestock. Producers are responsible for ensuring their livestock meet strict residue standards and should take all steps to ensure the stock feed is free of chemical residues … To

guard against any chemical contamination, producers must use the SAFEMEAT Commodity Vendor Declaration for all stock feed transactions'. Commodity Vendor Declarations can be downloaded from the internet on www.nvd.com.au; www.mla.com.au/nvd. Alternatively, they can be obtained from stock and station agents.

Any new food must be introduced slowly so that ruminal bacteria have time to adapt to the change in diet. If large quantities of fruit are fed to goats that are not used to it, they can cause severe diarrhoea or enterotoxaemia due to overgrowth of *Clostridium perfringens (welchii)*, which are normally present in the gut but which multiply rapidly with very rich feed. These bacteria also increase dramatically when grain is fed to stock that normally do not have access to it. We recommend revaccinating stock before beginning to feed grain or alternative feeds such as molasses, fruits, vegetables or other feed to which the goats are not accustomed.

Some fruits and plants should never be fed to stock no matter how hungry they are. These include avocado (*Persea americana*). Avocados contain a liver- and cardiac-damaging toxin which will eventually kill goats if sufficient quantities are eaten. The toxin contained in avocados is also known to trigger mastitis, because it causes inflammation of the mammary glands in goats and other livestock.

Two common trees whose foliage (especially the new red-coloured growth) can also kill rapidly are the cyanide-containing (prussic acid, HCN) eucalypts, manna gum (*Eucalyptus verminalis*) and sugar gum (*Eucalyptus cladocalyx*) (McKenzie 1996). Check carefully before feeding stock plants that are not normal feed.

Be wary of buying drought-stressed sorghum hay. In response to moisture deficit, sorghum produces cyanide and nitrites. drought-affected sorghum may kill stock quickly with no obvious clinical signs. The above examples of plants and fruit that can poison stock are only a few of the many dangerous ones. Appendix 1 lists several books about stock poisoning and there is a list of poisonous plants, symptoms of poisoning and remedies in Chapter 11.

Using trees and shrubs as feed

There are many trees and shrubs that can be used as drought feed, some more suitable than others. Lopping of native vegetation is regulated by the Native Vegetation Conservation Act 1997. Under the Act, lopping native vegetation for stock fodder in any period of declared drought is permissible if the continued health of the vegetation is not affected. Lopping of native vegetation for stock fodder may require approval from the Department of Lands and Water Conservation; in Queensland you should contact the Department of Natural Resources and Mining or its equivalent if your property is in another state. Legislation also covers private land so make sure that you have a permit before you cut, because the penalties are severe. On Crown leasehold land, you must obtain a permit before cutting down or destroying native trees and shrubs for stock feed.

When you have obtained a permit, decide if it is really necessary to destroy the entire tree by cutting it down, or if you can simply lop some branches. This decision depends upon tree species. Some trees, such as poplar box, will send up several shoots of regrowth from the root plate if cut down. Others, such as certain species of wattle, die if they are cut down. When using such wattle species it is best to lop some of the branches but not all,

because many do not reshoot from the trunk. Eucalypts usually reshoot from underground because they have lignotubers (to the regret of many farmers trying to clear land for crops). They also coppice from their stumps. So do some research before you cut and make sure that there will be feed left for the next drought. If you are new to the area and have no knowledge of local tree and shrub species, ask local farmers and graziers as they usually have some experience with the local species. The Department of Natural Resources or Forestry Department are also good sources of information.

When lopping trees and shrubs for fodder:

- don't cut more than the goats can eat in one day, because they usually won't eat any fodder that has started to wilt;
- choose a variety of different types of scrub if possible. This may help to provide a wider variety of nutrients in the goats' diet;
- start with the tastier varieties of shrubs and trees. Later, if goats are really hungry they will eat the types that they would have avoided earlier in the drought. We have accustomed our goats to eating small quantities of branches throughout the year, so they are used to eating browse;

Nutrient levels for most native trees and shrubs, with the exception of such shrubs as old man saltbush (17.86% CP, 10.70MJ/kg ME) are not high, but in drought survival is the name of the game. Many wattles (acacias) have a reasonable protein level of approximately 10.5% CP, not all of which is available because the high tannin content of most wattles interferes with the absorption of its protein.

Some acacia species commonly used in Australia for stock feed during drought are mulga (*A. anura*), black gidyea (*A. argyrodendron*), Blake's wattle (*A. Blakei*), wait-a-while (*A. cuspidifolia*), green wattle (*A. deanei*), ironwood (*A. estrophiolata*) and brigalow (*A. harpophylla*) (Everist 1969; Weller 1974).

Animal Science (1997) described a study in which goats and sheep were fed solely on a diet of golden wreath wattle (*Acacia saligna*) (all states except Tasmania) and cooba, willow wattle (*Acacia salicina*) (WA). The study concluded that neither species could be used as the sole feed for small ruminants because of low intakes and negative nitrogen balance. This appeared to be due to the high tannin content (Degen et al. 1997). Goats in this trial lost up to 219 g per day and sheep up to 346 g per day.

Our experience shows that wattle and other native shrubs can, with supplementation from other sources, eke out the feed remaining in your paddocks. The aim is to keep the stock alive until the drought finally breaks.

There are two species of wattle that should not be used for feed because they are known to have caused stock losses. These are georgina gidyea (*Acacia georginae*), which occurs in inland areas and coastal myall (*Acacia glaucescens*), in New South Wales and Queensland (Macquarie Dictionary of Trees and Shrubs 1986).

Feeding alternative feed

The following information may be useful when feeding out various alternative feeds to goats. It has come from many years' experience on our property and those of other producers throughout Australia.

Table 8.2 Approximate feed values of fruit and vegetables

Name	Protein (g/kg)	Energy (MJ/kg)
Apple	0.00	2.47
Banana	7.45	10.31
Cantaloupe	69.56	1.48
Capsicum	54.05	1.130
Carrot	97.2	1.745
Grapes	0.00	2.93
Honeydew melon	7.76	1.46
Lemon	17.2	1.10
Orange	7.63	1.92
Pawpaw	7.14	1.95
Peach	11.49	1.68
Pear	6.02	2.52
Pineapple	6.45	2.02
Pumpkin		1.159
Sweet potato	13.24	4.43
Tomato	8.13	0.85
Turnip	6.41	0.80
Watermelon	6.25	1.130

If you are feeding banana palms, cut the trunks into sections approximately 60 cm long so the goats can more easily peel off the layers of the trunk. Our goats are very fond of banana palm and have always been fed them even when there is no drought. Oranges, apples and other medium-sized fruit with firm skins should be cut, because a goat can swallow a whole fruit and choke on it.

Melons, pumpkins and pawpaws should be cut into chunks, as should large sweet potatoes. Goats are also very fond of the sweet potato vine itself. Before giving any of these feeds, we always wash them thoroughly in case they have been sprayed with something that may not agree with the goats' digestive system.

There is usually a surplus of mangoes during the growing season and they can be used as feed. Goats love them. Check the goats while feeding them mangoes, because the large oval seeds can become jammed in their mouth or throat and cause death due to choking or starvation.

Many native trees and shrubs such as bottlebrush (*Callistemon* spp.) grown in home gardens can be used as feed (see Table 8.3).

Table 8.2 lists the approximate protein and energy values of fruit and vegetable crops that can be fed to goats. As always, they must be introduced in small quantities and washed before feeding in case they have been sprayed with chemicals.

What not to feed

Some fruits, vegetables, trees and shrubs should not be fed to goats, as they contain toxins that may prove fatal. These toxins can be either swift-acting, such as those in oleander, or slow-acting, such as the liver- and heart-destroying cardiac glycosides contained in fruits

Table 8.3 Trees, shrubs and miscellaneous feeds

	Digestible matter (%)	Organic matter (%)	Acid detergent fibre (%)	Digestible dry matter (%)	Crude protein (%)	Metabolisable energy (MJ/kg)
Banana: *Musa* spp.	48.91	85.07	21.82	68.74	7.45	10.31
Belah				29–62	9.00	8.00
Blackberry			25.29			
Black wattle: *Acacia*	75.39	93.65	42.11	53.59	11.17	8.04
Bottlebrush: *Callistemon* spp.		95.97	45.77			
Citrus peel		94.92	17.92			
Corn stubble		90.00			4.8	5.5
Hairy wattle: *Acacia estita*		97.00	35.32			
Kurrajong: *Brachychiton populneum*					10.00	7.7
Lablab: *Lablab purpureus*		91.06				
Molasses	78.71			86.17	6.17	12.93
Oat stubble		90				4.6
Old man saltbush	55.44	79.37	23.97	71.34	17.86	10.70
Tagasaste	65.92	96.00	34.06	62.36	16.27	9.35
Wattle: *Acacia* spp.	94.07	95.98	39.79	55.37	10.85	8.30
Wheat stubble		90.00				5.1

like avocado. Table 8.4 lists some of the plants, fruits and vegetables in the home garden that should not be fed to goats. Plants in the solanum (potato) family should not be fed to stock of any kind, not just goats. Their poison may kill animals immediately; it will certainly kill them eventually if they continue to eat those plants.

Further information is given in Chapter 11.

After the drought

Reduced bodyweight due to drought makes stock more susceptible to adverse weather conditions such as temperatures of less than 10°C accompanied by rain, or less than 3°C in dry conditions. Very windy conditions also increase the energy requirements of goats. You can minimise losses by providing shelterbelts in paddocks or covered pens. Goats' resistance to chill factors in adverse conditions is low when they are in poor condition and heavy stock losses can occur if you are not careful.

What happens when the drought ends?

Eventually the drought will break, as all droughts do, rains will trigger pasture growth and the dams will fill. This is wonderful, of course, but it can bring different problems.

The first lush green growth of pasture after rain contains little metabolisable energy for six weeks or so, because there is little cellulose in new growth. Ruminal bacteria need the cellulose to produce the energy that goats require for various bodily processes. However, goats are not noted for having scientific brains – they eat the new growth with relish and

Table 8.4 Toxic garden plants

Feed	Part of plant	Toxin or effect
Avocado: *Persea americana*	All	Cardiac glycoside
Angels trumpet: *Datura* spp.	All: stock won't usually eat it because it is unpalatable but may if starving	Scopolamine and hyacyamine
Apricot: *Prunus armeniaca*	Leaves and branches	Prussic acid (HCN)
Azalea	All	Cyanogentic(glucosides and glycosides)
Black bean: *Castanospermum australe*	Seeds and plant	Cardiac glycosides
Castor oil plant: *Ricinus comminus*	Seeds and plant	Ricin is a cardiac glycoside
Cherry: *Prunus avium*	Leaves and branches	Prussic acid (HCN)
Coral plant: *Jatropha multifida*	All	
Lantana: *Lantana camara*	All	Liver toxin and photosensitivity
Morning glory: *Ipomea* spp.	All	Indolizidine interferes with function of certain cellular processes, especially those of the nervous system
Mother of millions: *Bryophyllum* spp.	All	Cardiac glycosides
Oleander: *Nerium oleander*	All: highly toxic	Cardiac glycosides
Peach: *Prunus persica*	Leaves and branches	Prussic acid (HCN)
Pigweed: *Portulaca oleracea*	All	Nitrate and oxalate
Poinsettia: *Euphorbia pulcherrima*	All	
Potato: *Solanum tuberosum*	All: tubers and plant	Solanine
Rhododendrons	All	Cyanogentic (glucosides and glycosides)
Rhubarb: *Rheum rhaponticum*	All	Oxalate
St Johns wort: *Hypericum perforatum*	All	Photosensitivity in light-skinned goats
Tomato: *Lycopersicon lycopersicum*	Leaves and stems. Ripe fruit is all right	Solanine
Yellow oleander: *Thervetia peruviana*	All (more in fruit): highly toxic plant	Cardiac glycosides
Yew: *Taxus baccata*	All	Liver-damaging toxin

ignore the higher energy- and protein-containing hay that you have provided at great expense.

The consequence can be that although the goats have a belly full of food, they continue to lose weight. The situation is only temporary and should not need any intervention, because it will be rectified as the nutrient levels in the feed begin to rise. If goats have had access to lick blocks or similar so that their vitamin and mineral levels are adequate, they will soon begin to regain condition.

If goats eat lush pasture and not the hay provided they will not obtain sufficient roughage and a condition known as hypomagnesaemic tetany (grass tetany) may result (see Chapter 9). Goats on new lush pasture should be checked each day for signs that they may be developing this condition, and treated before collapse. Response to treatment is rapid if affected goats are found and treated promptly.

If the first rains fall in summer and there is 40+ mm of rain all goats should be drenched, because those are the conditions favoured by one of the biggest killers of goats in Australia, Barbers Pole worm (*Haemonchus contortus*), which thrives in warm moist conditions. Our goats are drenched within a week of the first spring rains each year, with a broad-spectrum benzimidazole (BZ) or white-group drench such as albendazole. Two brand names for albendazole-containing drenches are Alben and Valbazen. See Chapter 10 for further advice on the management and treatment of parasites.

Young drought-affected stock whose growth has been severely affected will begin to grow again, but may never be quite as large or heavy as they would have been if there were no drought. Wethers destined for slaughter will take much longer to reach market weight and will therefore be older and less tender than markets, such as the restaurant trade, prefer. Such goats may have to be sold to less lucrative export markets such as the Taiwanese or Pakistani markets that prefer older and leaner goats.

Does will be smaller for their age than those not drought-affected and will not reach breeding weight (approximately 35 kg) until they are older. If you join does before they reach this minimum weight it may result in smaller and fewer kids and an inadequate milk supply. That would lead to slow growth of kids, who therefore take longer to reach market weight.

It is recommended that young drought-affected does not be joined until they have reached the minimum weight even if it means that they must be joined later in the year. Young does will be fertile at a much lower weight (approximately 25 kg) but should never be joined at that weight because of the reasons already stated. However, angora does are smaller than many other breeds and can therefore be joined at a lower bodyweight.

9

Health

When producers look at their goats and see them sleek, vigorous and healthy they can be assured that their husbandry practices must be correct. However, are they? We have had many frantic phone calls from producers asking for advice or help with sick stock. A number of the problems could have been prevented by correct vaccinating and drenching procedures, or by calling the vet early in the course of the illness.

A producer may breed goats for many years without problems but all it takes to introduce disease into a herd that was previously disease-free is one goat bringing disease or parasites onto the property, from elsewhere. Many diseases of the clostridial type such as enterotoxaemia (pulpy kidney) and tetanus can be prevented by vaccination; others, such as diarrhoea in kids, can be prevented by careful husbandry practices such as cleaning bottles and lamb-bars thoroughly after use. Careful observation (daily for pregnant animals) of your goats, cattle, pigs or alpacas allows you to recognise a problem before it becomes serious. The earlier that a problem in an individual or herd is noticed the less chance there is of it becoming a major one.

It is helpful to know what is normal for goats with regard to body temperature, respiration and so on. Table 9.1 may be used as a guide – like humans, each goat is an individual and normal vital signs vary slightly.

Apart from goats that deviate significantly from the normal range for TPR (temperature, pulse and respiration) or that have obvious injuries such as abscesses, wounds or fractures etc., there are other symptoms that should alert you to a possible problem with an individual goat or the herd. Early warning signs for potential health problems include:

- a goat standing away from the others and not eating, especially if it is standing with an unusual body posture, i.e. head hanging and body hunched, or head up and back and seemingly staring at something at a great distance (stargazing). Goats are herd

Table 9.1 Normal goat health

Temperature (rectal)	**39˚–40˚C**
Pulse rate	70–80 beats per minute
Respiration	15–30 per minute
Rumen movements	1–1.5 per minute
Oestrus	17–23 days
Gestation	143–155 days
Puberty	2 months (bucks) to 8 months. Remove bucks at two months.
Lifespan – bucks	8–12 years, average 8 years
Lifespan – does and wethers	11–20 years, average 11–12 years
Growth – birth to Maturity	3 years
*Dentition	Milk teeth: under 1 year old Centrals: 1–1.5 years Second incisors: 1.5–2 years Third incisors: 2.5–3 years Fourth incisors (full mouth) 3–4 years

animals and normally are afraid of being alone as it makes them a target for predators. Goats remove themselves from the herd only when kidding or when ill;
- abnormal faeces, such as diarrhoea or clumping droppings, or hard flint-like droppings;
- a goat lagging well behind the herd and having trouble keeping up;
- swelling of the feet and legs;
- swelling under the chin (internal parasites) or on the throat (goitre);
- unexplained weight loss;
- a dull starring coat, which resembles the bristles on a toilet brush, can be a sign of one of several deficiency conditions or, with other symptoms, of disease or illness;
- abnormal gait such as limping, staggering or an unusual walk such as the odd 'floating' gait of tetanus;
- any abnormal discharge such as blood, pus or mucus from the vulva, mouth, eyes, ears or other part of the body;
- loss of hair from the face or body that may or may not include scaling.

A goat exhibiting any of these symptoms should be investigated as soon as possible.

Nutritional and metabolic diseases

Cerebrocortical necrosis (stargazing)

This condition is due to an acute deficiency of thiamine (vitamin B1), normally produced in the rumen (first chamber of the stomach). In cerebrocortical necrosis, thiaminase, an enzyme that destroys thiamine, is present in the rumen and produces a thiamine analogue which replaces thiamine in important metabolic reactions in the brain. This causes necrosis of the brain (death of brain tissue). If not treated swiftly, death will occur even if treatment is initiated, due to the amount of brain tissue that has been destroyed.

The condition is often caused by ingestion of thiaminase-containing plants such as bracken fern (*Pteridium esculentum*), rock (or mulga) fern (*Cheilanthes sieberi*) or nardoo

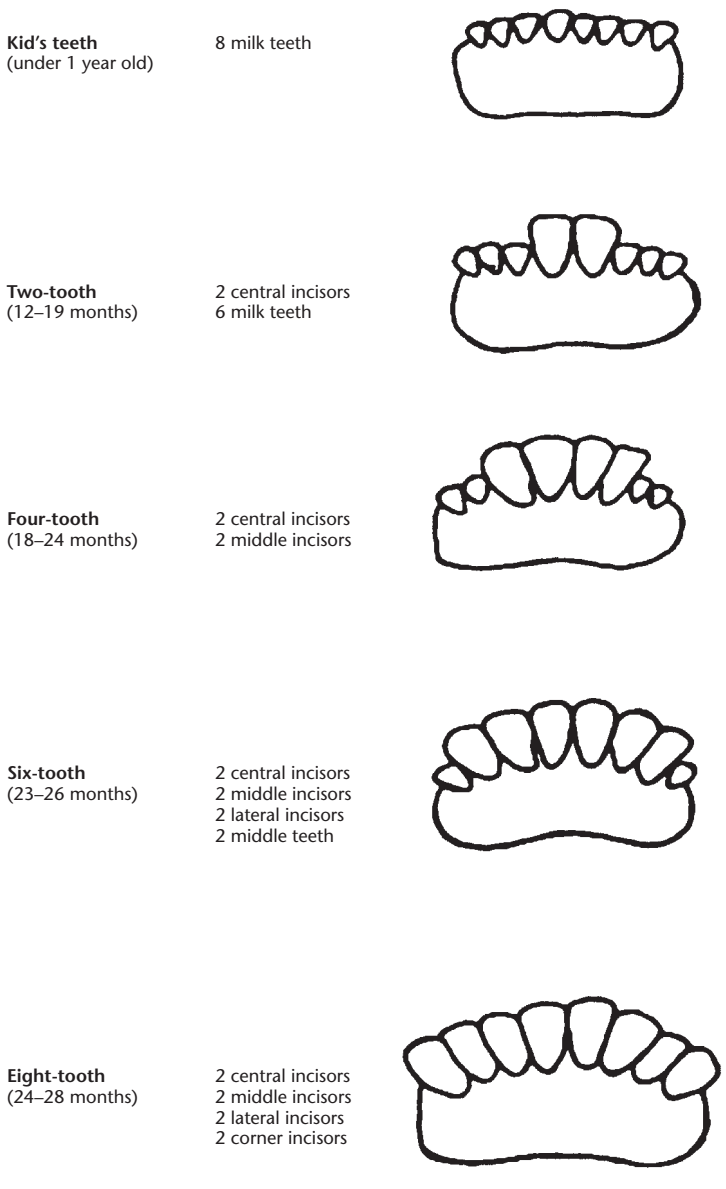

Figure 9.1 Judging a goat's age by its teeth

Source: Department of Primary Industries & Fisheries (Qld) ©

(*Marsilea drummondii*). Lush parts of the plant contain more toxin than other parts. Nardoo contains more toxin than mulga fern and there is more toxin in mulga fern than in bracken. These ferns are usually the first plants to shoot after a dry period and there may be large quantities of them in paddocks before the pasture begins to show significant growth. Under these conditions, goats will eat enough of the plants to cause problems. The condition may also occur if goats are given large quantities of molasses or there is a sudden increase in their amount of concentrate (and insufficient roughage). This precipitates an overgrowth of the ruminal bacteria that produce the thiamine-destroying thiaminase.

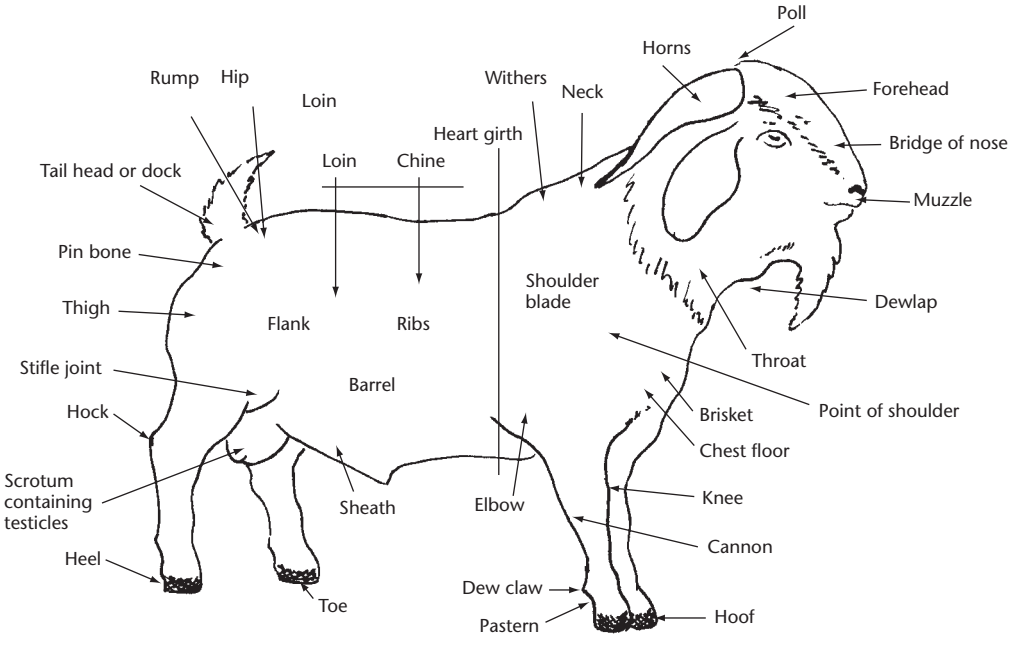

Figure 9.2 Parts of a goat

Clinical signs

Clinical signs include:

- stargazing – head up and back. The animal seems to be staring at something far in the distance;
- disorientation and aimless wandering;
- seems blind, but pupils still react to light;
- nystagmus – oscillating eyes;
- strabismus – the goat may appear cross-eyed;
- lateral recumbency – head thrown back and the legs extended stiffly;
- clonic convulsions;
- terminal coma.

Treatment

Response to treatment is dramatic if it is given early, before there is too much brain damage. We have seen goats on their feet within a few minutes and grazing as if they had never had a thing wrong with them. The treatment consists of an initial intravenous injection of 5 mL of vitamin B1 (thiamine) then 5 mL intramuscularly every six hours until the doe has recovered. We continue the injections for 24 hours, which means that the goat will receive five injections of thiamine in a course. If the goat has only been mildly affected, one or two injections may be enough.

Prevention

Management technique can help to control this condition. If certain paddocks have a significant growth of problem ferns, rotate the goats to a cleaner paddock until there is enough grass or other grazing in the problem paddocks. If the ferns grow over large areas of

the property and it is not possible to rotate the goats to paddocks that are clear of these species, goats be given ad lib access to good-quality hay –goats will eat less fern if they aren't too hungry.

The Department of Primary Industries or its equivalent will give advice on measures for reducing the amount of ferns so that you can lessen the possibility of goats suffering from this condition in the future.

Pregnancy toxaemia

This is also known as ketosis or twin-kid disease, because a doe suffering from it is often carrying multiple large kids. It occurs during the final six weeks of pregnancy when the growing foetus places increasing demands on the blood-glucose supply of its dam. The principal source of energy utilised by growing kids is glucose, at the expense of their mother. If the doe is in a good state of nutrition this is not a problem. However, If energy use exceeds energy intake and the situation is not rectified promptly, the doe will develop hypoglycaemia (low blood glucose). If the producer does not notice the symptoms early enough the hypoglycaemia will progress into full-blown ketosis – the blood level of ketones rises due to the digestion of free fatty acids and amino acids to try and meet energy requirements because of increasing foetal demands. The effect of ketones on the brain is to reduce the goat's appetite, further aggravating the condition. When blood glucose falls from 30–45 mg/100mL to 18 mg/100 mL, pregnancy toxaemia can develop.

When blood levels of ketones rise bicarbonate levels in the blood decrease and this may result in acidosis. If the blood level of bicarbonate continues to decrease, the animal will eventually become comatose and finally die.

The demands on a doe from rapidly growing kids are great, especially if does are carrying multiple foetuses. For example, a South African Boer doe may be carrying triplets: the kids weigh 3.5+ kg each, the membranes weigh 1+ kg and there is up to 9 L of amniotic fluid – a total of approximately 20 kg. This is a lot to ask of an animal that when empty (not pregnant) probably weighs no more than 60 kg itself and it is therefore not surprising that often the animal cannot meet the growing kids' demands and pregnancy toxaemia results. The larger the animal, the more likely it is that it will be carrying multiple large foetuses and thus the majority of pregnancy toxaemia cases occur in larger animals such as dairy goats or Boer goats.

The big fat doe that is always first at the feeding trough, aggressively pushing other goats out of the way to eat more than her fair share of the grain, is a prime candidate for pregnancy toxaemia. If this very pushy type of doe begins lying around a lot during her final four weeks of pregnancy and even defecating when lying down, suspect pregnancy toxaemia.

Other causes of pregnancy toxaemia are:

- separation anxiety – goats like to form small family groups and if one in the group dies or is removed from it, others can fret and refuse to eat. They then begin using their fat reserves and ketosis results;
- nematode infestation (worms) – intestinal parasites cause reduced appetite and therefore reduced intake of feed which can lead to pregnancy toxaemia if not addressed promptly by appropriate drenching;

- cobalt deficiency (B12) leading to inappetence (lack of appetite);
- transportation – goats should not be transported in late pregnancy. The stress of transport, including yarding and handling, may not only cause reduced feed intake leading to pregnancy toxaemia but can also cause abortion. Does should not be transported after their twelfth week of pregnancy;
- poor feet or teeth – overgrown feet may make walking painful and a goat will not be able to travel the distances needed to obtain sufficient feed for herself and her pregnancy. Poor teeth due to a broken mouth (old age) or a misaligned jaw may impede the ability to forage.

Clinical signs

The clinical signs of pregnancy toxaemia include:

- loss of weight;
- loss of appetite;
- sunken eyes;
- loss of fear of dogs;
- aimless wandering;
- headpressing;
- stargazing (similar appearance to thiamine deficiency);
- convulsions and coma;
- sweetcorn-smelling breath, due to the presence of ketone bodies;
- ketones in the urine, detected with dipsticks available from the vet;
- paddling in recumbent animals.

An overfat greedy animal:

- approximately four weeks before her EDOK (estimated date of kidding) the doe will spend a lot of time lying around and may even defecate while lying down. Upon checking, you may see a pile of dung directly behind her rear where she is lying;
- she may not show much appetite, whereas formerly she was first at the feed trough;
- approximately two weeks before EDOK her feet and lower legs may start to swell and she may limp or be reluctant to walk;
- at the same time she will lose her appetite;
- when she is one week from kidding, she will not stand unless assisted and will not eat;
- the terminal phase usually last two or three days. In this phase the doe will moan, have laboured respiration and sunken eyes. She usually dies two to three days before she is due to kid.

If herd animals are affected it is often due to starvation, for example heavily pregnant does suffer during drought when there is not enough feed in the paddock for their needs and those of their foetuses. Daily observation is vital, but even if you don't notice the signs straight away treatment is worth trying if the animal has obviously not been down too long.

A stricken doe is usually found on her own, near shelter. Her respiration is laboured and her camp is surrounded by flinty droppings that are often covered in mucus or joined together by strings of mucus, so that they resemble a string of beads. The droppings are frequently shorter and wider than normal and are often indented at the rear end and

pointed at the front as though they have been pinched to a point. These droppings indicate that she has not eaten for a few days. If she has been down any time at all, treatment will probably fail. She may attempt to kid on the day she dies.

We have found that she is not usually successful at kidding; if she is, the resulting kids are rather weak and will need a lot of care. They may be born dead. Prevention is always better than cure, so it is good husbandry practice to try to watch your goats going to their camp each evening or going out in the morning, so any does in trouble can be found and treated before the problem becomes serious.

Treatment

Treatment is seldom successful unless begun early in the illness. The aim of treatment is to correct the energy imbalance. There are two commonly used methods for doing this.

The first method is to drench the doe twice daily with a drench composed of 120 mL propylene glycol or glycerine, mixed in an equal volume of water, given with a drenching syringe or any other large syringe. Ensure that the drench is not introduced into the trachea (windpipe) because it may enter the lungs and cause pneumonia. Drenching the doe slowly so that she has time to swallow the solution should avoid this problem. Never try to drench a comatose or very weak animal.

If the doe is in a state of collapse or doesn't want to swallow, you will need to give glucose as an intravenous or subcutaneous injection, under the instruction of a vet. Several brands of oral drenches are marketed for the treatment of pregnancy toxaemia; the main ingredient is propylene glycol but they may contain other ingredients such as choline chloride and cobalt chloride.

The second method is to give 100–200 mL of a 50% glucose or dextrose solution intravenously. You will need instruction and equipment from the vet. If done before the goat collapses, response is usually rapid. Follow this up by drenching twice daily with the propylene glycol or commercial pregnancy toxaemia drench for the next two or three days. Some producers have found vitamin A and D injections to be helpful as an adjunct to, but not replacing, the propylene glycol or glycerine drenches.

The doe may not want to eat for the first few days but you can stimulate her appetite by force-feeding fresh weeds, grasses and leaves. Roll small handfuls into balls and, while holding the goat's head, push each ball well back into the rear of her mouth. Make sure that you give the goat time to swallow between mouthfuls. A word of warning on force-feeding, learned from painful experience: be careful of your fingers when force-feeding a goat, because they have razor-sharp molars evolved for dealing with very tough woody weeds and shrubs.

Sometimes the vet can save the kids and doe by doing a caesarean section if the pregnancy is of 145 days or more. After the kids are delivered there is often a rapid improvement in the doe's condition.

1. If all treatments fail and the doe becomes comatose, there is usually little hope of recovery. Salvaging the kids is the only option. Call the vet early in the illness to prevent deterioration of the kids.
2. While you are waiting for the vet, milk out any colostrum and save it to give the kids after they are delivered.

3 If the vet decides that the doe cannot be saved, she will be euthanased and her kids delivered by caesarean section.
4 As the vet delivers each kid, clean their mouths and noses and dip the cords in Betadine to prevent bacterial infection.
5 Rub the kids thoroughly to stimulate their circulation. The doe normally stimulates each kid as it is born by licking it.
6 After the kids are clean and dry they should be offered their first feed of colostrum, either from their dam or from another doe. If there is no natural colostrum available, you can offer the artificial type (see Chapter 5) or a commercial substitute.
7 After feeding, put the kids in a foam box with a hot water bottle for a few hours to make sure that they are warmed up. Their core temperature is often depressed because of their dam's illness and they may feel cooler ' than is normal for newborn kids. Offer colostrum every two hours and return them to their box between feeds to keep warm.

By the next day, all being well, they should be fine and demanding to be fed. Care for them as you would any other orphan kids.

Prevention
Don't let the does get too fat in early pregnancy. Ensure that does are on a rising plane of nutrition during their final six weeks of pregnancy so that their needs and those of their growing kids are met. If your pastures are always short of good grazing when does are in their final six weeks of pregnancy, try to have your kids drop later in the season when there will be adequate grazing, or supplement their grazing with concentrates.

Check the condition of pregnant does often, so that problems may be detected before they become major. The majority of metabolic diseases in goats can be prevented by careful management – most of the time, anyway (Karlsson 1984; Baxendell 1988; Nelson et al. 1992; Brown 1981)!

Ketosis (acetonaemia)

Because the symptoms of ketosis appear six to eight weeks after kidding, the disease is often confused with parturient hypocalcaemia (milk fever), a condition due to a metabolic problem with blood calcium levels.

High-yielding dairy animals, which includes South African Boer goats, may experience a net loss of energy early in lactation and be in a state termed subclinical ketosis (no symptoms) because they are eating insufficient food for the demands of lactation and other bodily requirements. Food intake often lessens during late pregnancy because the growing foetuses takes up enough bodily space that there is little room for ruminal activity; this lowered intake may continue after kidding. Four to six weeks after kidding, hormonal stimuli for lactation may overcome the effects of inadequate feed intake. If the feed intake is below that required for lactation and other bodily functions, the doe may develop full-blown clinical ketosis.

Ketosis can be precipitated by large quantities of concentrates that can cause a metabolic imbalance and result in acidosis. Other things which may trigger ketosis in goats are:

- faulty feed rations that are too low in protein or carbohydrate;
- indigestion from faulty feed containing too much bran or pollard;

- a goat gaining access to the feed shed when a door is accidentally left open – this may result in complete lack of gut motility and acidosis;
- feeding large quantities of fruit and vegetables when the goat is not accustomed to them;
- stress – this may reduce feed intake and affect the metabolic process.

Clinical signs
The more severe clinical form of this condition may include the following symptoms:

- decrease in appetite;
- rapid loss of condition;
- flinty droppings with pointed ends;
- depression;
- signs of abdominal pain (Karlsson 1984);
- ketones on breath (sweetcorn smell).

The doe will usually make a full recovery in a few weeks. The condition is not usually fatal, except in rare circumstances.

Treatment
Treatment is the same as for pregnancy toxaemia. There are hormone treatments for non-pregnant animals that will help to raise blood glucose levels.

In cases of acidosis due to gorging on grain, acidosis may be reduced by drenching the doe with a solution of bicarbonate of soda: 500 mL of a 5% solution. An initial dose of 100–150 mL will stimulate the oesophageal groove to close, ensuring fluid flows directly to the abomasum (fourth stomach). This drench should be given prior to the propylene glycol drench. Hungerford (1990) suggests that injections of vitamin B12 can be valuable in the treatment of ketosis.

Do not feed concentrates until the doe has recovered, but do give her all the fresh leaves, weeds and branches that she will eat.

Prevention
Introduce new feeds slowly to give rumen bugs time to adapt, don't let the does be too fat at the start of the breeding season and include as much roughage as the doe will eat if it is not available in the paddock (this is the main source of metabolisable energy for goats).

Periparturient oedema

This condition resembles ketosis but there are some differences between the two conditions. The cause is not really known although it has been theorised that it could be due to inability to cope with pregnancy, as the condition is most often found in does carrying large multiple foetuses and it resolves itself within a day or so of kidding.

Clinical signs
A doe with periparturient oedema:

- may have swelling in the lower front legs at first, later extending to the hind limbs;
- does not lose her appetite (as a doe in ketosis may);
- prefers lying to standing;

- has a slow gait that appears to be painful and the goat may groan as she is walking or attempting to stand or lie down;
- should not show a high urinary ketone level when tested;
- may show conditions associated with fluid retention such as a rise in blood pressure, decrease in blood protein and blockage of the lymphatic system.

Treatment

First, test for worms via a faecal egg count. If the result is positive drench her, but do not use products containing albendazole or closantel as they can cause problems during pregnancy.

Check ketone levels in the urine, using dipsticks available from the vet. They are not very expensive and we always keep a supply in our stock medicine cupboard in case if emergency.

Pay attention to nutrition and make sure that the doe is on an increasing plane during the final six weeks of pregnancy, which is when this condition usually manifests itself. We have mistaken this condition for ketosis and treated the does for it using drenches of propylene glycol and intramuscular injections of vitamin B12. We did not lose any does and giving the propylene glycol for extra energy may have helped – at least it did not do appear to do any harm.

The condition resolves itself within a day or so of kidding, but the doe may need to be supported in a standing position to allow the kids to feed for the first day or two after she kids.

Further research into periparturient oedema is being undertaken, so perhaps one day an answer to the puzzle will be found.

Parturient hypocalcaemia (milk fever)

This metabolic disease in goats follows kidding and occurs because of low blood calcium levels. The production of colostrum (first milk) puts a high demand for calcium on the doe as colostrum contains twice the calcium of milk. This demand is met from two sources – diet, and calcium mobilised from the doe's bones.

If the diet is low in calcium following parturition, the need is normally met by calcium mobilised from the bones. However, this skeletal calcium is not always enough to meet the demands of lactation, especially in older does that have fewer calcium receptors because these decrease as does age. The condition commonly occurs within 72 hours of kidding.

Clinical signs

A doe suffering from milk fever:

- is unable to stand;
- is recumbent, usually on her chest with her head turned to the side. When the neck is straightened, the head promptly turns to the side again;
- has slow and forced respiration;
- has a very weak and drawn-out bleat;
- may show trembling of the muscles, lips and ears;
- has a subnormal temperature – ears feel cold;
- may develop tetanic convulsions.

Treatment

Treatment is by the administration of calcium borogluconate given intravenously or subcutaneously under the loose skin of the neck. Goats will take 100–120 mL of the IV solution marketed for milk fever in cows as two doses of 50–60 mL. If the solution is not being given under a vet's instructions it should be given subcutaneously – when given intravenously the solution sometimes causes the heart to 'race', which can kill goats.

The solution must be given slowly and steadily. If forced in too quickly it can be very painful for the doe. The needle gauge should be 18 or even 16 because the solution is quite thick and it is difficult to force it through a finer gauge. A needle 2.5–4 cm long is quite long enough. The needle in the 'giving pack' of milk fever solution is too large for goats, because it is designed for cattle.

We draw off the amount we need from the pack and store the remainder in the refrigerator. If a sterile needle is used for drawing off the amount needed for a treatment, so that the remainder is not contaminated by bacteria, the solution will last until the use-by date.

The solution is available from rural suppliers and vets and usually costs around $20 per 500 mL pack. We keep a fresh pack in the refrigerator during kidding season, as milk fever always seems to strike when you least expect it.

When treatment is given early in the course of the disease, the response is dramatic. The tetany should begin to subside within an hour of the first treatment and the doe is often up and eating within 12 hours. We usually give the other 50–60 mL of solution 8–12 hours after the first, depending upon the time of day that the first injection was given and the condition of the doe. If the doe is under veterinary treatment you will follow the vet's instructions, because each case is different and there may be other problems that the vet is also treating.

Prevention

The doe must begin mobilising calcium stores from her skeleton during the final six weeks of gestation. Calcium licks such as lime and dolomite should be removed during this period, so that any extra calcium is supplied from the skeleton. We return the calcium to the does as they kid. All newly kidded does are moved into a separate paddock with access to calcium in the form of dolomite, which also contains magnesium. Magnesium is important for Ca_{2+} metabolism for three reasons: it influences the ability to resorb Ca_{2+} from bone (via parathyroid hormone), facilitates the activation of vitamin D in kidneys and promotes Ca_{2+} absorption from the gut (Kelly 1988).

If does in their final month of pregnancy are being fed high-quality lucerne (which contains high calcium levels) it must be replaced with a grass hay which has lower calcium levels. Reduce gradually, over the course of a week, giving more of the grass hay and less of the lucerne each day until the does are receiving only the grass hay.

Hypoglycaemia in newborn kids

The blood sugar of newborn kids can be low for several reasons, the most common of which are:

- dystocia where the birth is long, protracted and perhaps assisted;
- dam with low bodyweight or in poor condition;

- chill at birth (rain or cold);
- multiple birth.

Clinical signs

Signs of hypoglycaemia are a weak kid with a low body temperature, who may stand hunched and look depressed. The final sign is terminal convulsions.

Treatment

Treatment involves giving glucose injections if available. If they are not, give the glucose via a stomach tube if you know how to do so. The treatment must be given early to have any success. You should also warm the kid to raise its core (internal) temperature (see Chapter 5).

Floppy kid syndrome (FKS)

This condition occurs in newborn kids usually under two weeks of age. It is not confined to any particular breed nor is it confined to bottle-fed kids, or kids fed by their own mother. It may be caused by clostridial-type AE bacteria ingested when kids eat dirt. In fact, kids with the condition often have dirty faces and mouths, indicating that they have been eating dirt. It is believed to be treatable if caught early. In the US, it is usually seen when the weather warms up (Walters 2005).

Clinical signs

The kids seem normal at birth but develop a sudden severe muscle weakness, often with ataxia, and may show flaccid paralysis. The kids are reluctant to suckle (possibly because they are so weak) but they can swallow at first. They may also seem depressed.

As this condition can resemble others such as white muscle disease and colibacillosis, diagnosis must be made on the results of clinical tests on blood chemistry to assess the severity of the base deficit and electrolyte imbalance. Tests may reveal metabolic acidosis with no detected repeatable abnormalities in specific organ systems with the exception of mild renal changes in some cases (Kimberling 2005).

Treatment

Treatment is primarily aimed at addressing the acidosis and electrolyte balance. If noticed early, a solution of bicarbonate of soda can be given. We mix two level metric teaspoons in 250 mL water and give 100 mL of this solution via a stomach tube.

If the case is more advanced and the kid is suffering flaccid paralysis (and is valuable), the vet can treat the kid with isotonic intravenous 1.3% sodium bicarbonate solution. A dramatic improvement occurs after intravenous fluids are administered. Kimberling has noted that antibiotics and vitamins do not seem to be of any benefit in treating the condition. Relapses often occur.

The syndrome has also been reported in cattle, llamas and sheep. The mortality rate in goats is 30–50% of affected kids.

Hypomagnesaemic tetany (grass tetany)

Not a common problem in goats, at least compared to sheep and cattle. This condition is often associated with lactating does being given access to lush pasture, especially if they are

not used to it. It can also be precipitated by transportation or other stress or a period of starvation.

Clinical signs
These include:

- staggering gait;
- lateral recumbency – lying on the side;
- twitching muscles and ears;
- nystagmus – oscillatory movements of the eyeballs;
- convulsions (can be triggered by touch or sound) and foaming at the mouth;
- coma and death.

Treatment
Response to early treatment is rapid. There is a specific treatment for this condition, but the treatment for milk fever is usually used. The first injection should consist of 60 mL of solution; if the response is poor, a second 60 mL injection can be given 12 hours later. Milk fever solution is commonly used in treatment because the condition involves hypomagnesaemia, hypocalcaemia and hypophosphataemia (Baxendell 1988).

Urinary calculi (kidney stones)

The condition is a metabolic disease known by many names, including urolithiasis, water belly and calculosis (US). It occurs in male ruminants because their urethra is much longer and less expandable than those of females, who pass calculi easily through their shorter and more flexible urethras. It happens when concretions (stones) that consist of magnesium and ammonium phosphate form within the urinary tract and block the flow of urine, often resulting in the rupture of the urethra or bladder and pooling of the urine in the abdominal cavity. Hence the common name of water belly. The animal dies a very miserable death.

The disease is caused by a mineral imbalance between calcium and phosphorus levels in the diet. Goats require a balance of calcium 2:phosphorus 1. Mineral imbalance normally results from too many concentrates and too little roughage in the form of grazing or good-quality hay. The disease can also be the result of feeding rations intended for a different species, for example cattle rations being fed to goats. Cattle rations usually contain too much phosphorus for goats and feeding these to bucks or wethers, that are even more susceptible to the condition, often leads to the rapid formation of urinary calculi.

A male goat's urethra has three curves and is long, with a 2–3 cm urethral process at the tip of the penis. Calculi tend to lodge either at the last curve of the urethra or at the beginning of the urethral process because it is slightly narrower than the urethra. If the obstruction is not removed early enough the wall of the urethra will be damaged. Even if the goat is cured, there may be so much urethra and bladder damage that the animal will not be any good for breeding purposes.

Urinary calculi are more likely to occur when goats have a reduced water intake in winter when water is very cold or even frozen: in the US, elements to heat stock water are available because it is such a common problem there. Urinary calculi can also occur in very hot dry conditions when water is not very palatable because of its temperature, taste (low dam levels) or high salt content (brackish). These circumstances result in phosphorus salts

becoming more concentrated and this can permit the formation of concretions in the urethra.

Clinical signs

Unfortunately the clinical signs do not develop until there is already partial or complete blockage of the urethra and damage has already occurred. The main symptoms are:

- uneasiness and frequent attempts to urinate;
- the area around the tip of penile sheath may be wet and dribbling urine if the blockage is only partial;
- there may be deposits of crystals on the preputial hair (Nelson 1992);
- the animal may be off its feed and withdraw from the herd;
- kicking at the abdomen in discomfort;
- if the bladder or urethra bursts the symptoms are relieved for a time, but eventually the animal will collapse and die;
- in the case of rupture, the belly may swell due to the collection of fluid.

Treatment

If the calculi lodge at the beginning of the urethral process, removal of the urethral process often allows enough space for the stone to pass out of the penis. Removal of the urethral process does not cause any breeding problems for the buck, but he may have already sustained too much urethra and bladder damage to be any use for breeding. A wether can be grown to sale weight with no further problem, as long as the dietary imbalance is corrected.

Offer containers of stock salt to animals to encourage them to drink more. Goats have a liking for salt and will readily eat it. Feeding ammonium chloride at the rate of 0.5–1% of the total ration can help to prevent urinary calculi if it is a continuing problem despite efforts being made to correct any dietary imbalance (Nelson 1992).

Ammonium sulphate can be used instead of ammonium chloride, at the rate of 0.6–0.7% of the total ration (Smith & Sherman 1994).

Clostridial diseases

Bacteria of the clostridial type cause diseases such as enterotoxaemia and tetanus and are arguably some of the biggest killers of goats in Australia. They rank closely with *Haemonchus contortus* (Barbers Pole worm) in causing large stock losses in the grazing industry.

Most of the clostridial diseases can be prevented by a good vaccination program. The first vaccination should be at six to eight weeks of age, followed by a second injection four weeks later. Booster shots are given annually for bucks and wethers and twice-yearly for does. When giving injections to mature bucks, it is usually necessary to use a larger-gauge 16×5 cm needle because bucks have an extremely tough and thick hide. Finer-gauge needles often bend.

Does receive an extra booster vaccination six weeks before they are due to start kidding. Giving this booster four months after the bucks are put into the herd should ensure that the does have the maximum possible protection from enterotoxaemia and tetanus and that protection is at its peak when they kid and are most vulnerable. The booster vaccination for

pregnant does also gives passive immunity to their kids through colostrum, which will protect them until their first vaccination.

Vaccination for clostridial diseases should not be given to kids before they are six weeks old. Before this, immune response to the vaccination is very weak and there will not be good immunity to clostridial diseases.

Tetanus

We believe that all goats and their handlers or people working around livestock should be vaccinated for this terrible disease. Tetanus is caused by the bacterium *Clostridium tetani* that is present in soil, dung, dust, hair and skin of mammals, humans as well as goats. The spores remain infectious for years and are not destroyed by most common disinfectants (Newman 1996). Spores live in the gut of most grass-eating animals, including cattle, goats, sheep and horses. They pass out in the dung without causing symptoms; problems begin when the spores enter wounds where the anaerobic bacteria (which proliferate in the absence of air) develop and begin to produce their deadly toxin.

The types of wounds in which the bacteria can develop include puncture wounds from bites, standing on nails, or branches puncturing the goats when running through scrub. They may develop in wounds from castration, dehorning and even bruising.

As tetanus bacteria develop in the absence of oxygen, best practice is to open contaminated wounds. Wear gloves and eye protection and use a sterile scalpel. When wounds are opened, thoroughly clean them using a solution of 1 part 6% hydrogen peroxide to 4 parts sterile (boiled and cooled) water. This will 'fizz' out debris in the form of blood, pus and foreign materials such as dirt. We use a 20 mL syringe to flush out the wound and have found it ideal for the job. Do not stitch the wound – leave it open so that the interior of the wound is in contact with the air.

The incubation period of tetanus is 10–20 days after the initial wound but it has been seen as early as four days after disbudding a week-old kid. Tetanus due to dystocia (a difficult kidding) usually appears about a week later (Brown 1981).

Clinical signs

Clinical signs typically include the following:

- stiffness of the limbs when walking – if the goat is forced to move quickly, both hind limbs will often move together so that the goat appears to float along (Brown 1981);
- stiffness of the tail;
- ears pulled together at the base of the forehead;
- drooling;
- third eyelid showing across the eye;
- difficulty opening the mouth (lockjaw), but goats can suck fluid and swallow it at first (Brown 1981);
- overreaction to sudden noise such as a clap;
- finally, the goat will collapse with its legs extended stiffly and head arched back.

When the animal collapses, death usually occurs within 36 hours.

Treatment

This is expensive and often unsuccessful. It involves treatment of the wound and large doses of tetanus antitoxin and penicillin. To have any chance of success, treatment must begin soon after symptoms are noticed. Prevention is the best policy.

Prevention

The best prevention is annual vaccination of the main herd and of does six weeks before kidding. It has sometimes been suggested that tetanus antitoxin be given along with the first vaccination at marking, as it gives immediate protection and lasts two to three weeks. The second vaccination should be given in the normal way four weeks later. This is an expensive way of providing protection, so it is better to vaccinate does six weeks before kidding.

Cleanliness is also very important in the prevention of tetanus, because most disinfectants are ineffective against tetanus spores. It is imperative that all instruments used for stock be cleaned before and after procedures such as earmarking or tagging. The instruments should be stored in a clean, dust-free and dry place until next required. If a procedure that involves breaking the skin is being done in dusty yards the ground should be watered to lay the dust before beginning. Another solution is to set up temporary yards, using portable panels, in a grassy dust-free area.

Prices of vaccines per dose vary with the size of the pack but generally the larger the pack, the lower the per-dose cost.

Enterotoxaemia (pulpy kidney)

Enterotoxaemia is caused by toxins produced by the bacteria *Clostridium perfringens (welchii)* type D. Enterotoxaemia is a major disease of goats and occurs in three forms: peracute (very severe and fast), in which the goat is usually found dead; acute (fast and severe); and chronic. The disease occurs when these bacteria, which are normal residents of the digestive tract, multiply excessively due to the presence of highly digestible substrates (e.g. starch) and/or slowing of the gut movement.

The sudden introduction of large quantities of rich, lush green feed or high-carbohydrate feeds are major causes, as is gorging on grain, poultry feed or molasses if the feed-shed gate is left open. Giving 'heating' bran and molasses mashes after kidding can also trigger an overgrowth of *Clostridium perfringens (welchii)* type D.

Clinical signs

- Peracute – animals are usually found dead. Sometimes there are signs of staggering, convulsions or shock but there is usually no scouring. Death can occur within two hours.
- Acute enterotoxaemia – yellowish-green diarrhoea, that changes to gelatinous whitish mucus within a few hours. Later, blood can be seen in it. Finally, large clots of blood and sheets of bowel lining are passed. The goat's core temperature falls from a norm of 39–40°C (rectal) to as low as 33°C. If you do not have a thermometer, place a finger in the goat's mouth – a subnormal temperature will be obvious because the inside of the mouth will feel quite cool. The goat's ears will also feel icy and she will be shivering. The goat will lie down, convulse frequently with a paddling motion of the legs, cry out in pain and soon die.

- Chronic enterotoxaemia – this is not common. It is characterised by bouts of scouring, depression, fluctuating appetite and wasting.

Treatment

The best treatment is prevention because this disease strikes so rapidly that treatment is usually impossible. Treatment is also extremely expensive because it involves the use of pulpy kidney antitoxin and antibiotics.

Prevention

The best prevention is through vaccination and attention to diet, for example introducing new feeds slowly and denying access to the feed shed.

Black disease

This disease, also known as infectious necrotic hepatitis, is usually secondary to liver damage caused by infection with the liver fluke *Fasciola hepatica* (see Chapter 10). Spores of *Clostridium novyi,* another of the clostridial bacteria, survive in pasture and soil for years, until they are ingested by stock feeding in the pasture. Eventually the spores find their way to the liver and can remain there, causing no apparent harm, until a fluke infection damages the liver near the dormant spores. Once activated, the spores produce a toxin that causes the disease.

If stock die suddenly and the cause is unknown, it is good practice to have the vet do a post-mortem examination to determine the cause of the death. Symptoms can resemble those of several other clostridial diseases such as enterotoxaemia. A definitive diagnosis may have to be made by a laboratory.

Clinical signs

Black disease mainly occurs in sheep but can also affect cattle and goats. Symptoms include:

- skin on the lower legs and mouth are cold to touch;
- normal ruminal sounds are absent;
- abdominal pain;
- loose bowel motions with semi-fluid faeces;
- lack of appetite;
- depression;
- reluctance to move.

Stock usually die quietly without struggle within 48 hours, or are simply found dead in the paddock.

Treatment

This is usually not successful and if you suspect an outbreak of this condition in your stock, you should contact your vet for advice immediately.

Prevention

As with other clostridial diseases, the best treatment is prevention by vaccination. Vaccination is not going to prevent the goats getting liver fluke infection, however. That is controlled by drenching at the correct time of year.

Caseous lymphadenitis

This disease, caused by the bacteria *Corynebacterium pseudotuberculosis ovis*, is commonly known as cheesy gland because of the thick cheese-like consistency of material inside the abscesses. The bacteria, from dung and soil around camps, pens and yards, gain entry through wounds. They are carried in the gut and shed in the dung and can be spread through contaminated equipment such as shears. They can survive up to seven days in hot dry conditions and up to 20 weeks in cool moist conditions.

This disease, which causes abscesses in the lymphatic system, lungs and internal organs of goats and sheep, costs Australian producers and processors an estimated $15 million each year. Approximately 50% of all carcass condemnations in Australian abattoirs are due to cheesy gland. Of the adult sheep slaughtered in Australia, 0.5–1% are condemned due to cheesy gland. The presence of cheesy gland in Australia is the reason some countries reject our lamb and mutton.

CLA can be transmitted to humans and may cause very severe illness so gloves and eye protection must be used when treating any abscess. Abscess material accidentally sprayed into the eyes rapidly enters the body and starts a possibly life-threatening infection.

Common sites of infection in goats are just behind the point of the jaw, on the neck just above the collarbone and on the udder. Infection on the hind legs or the flanks is more common in sheep than in goats, but does sometimes occur. Abscesses in the lungs and internal organs are more difficult to detect and are often only found at autopsy. Abscesses may measure 20–40 mm in diameter and the pus, as the name suggests, has the consistency of soft cheese. In older lesions the contents are quite firm. If allowed to rupture without treatment, the pus has a characteristic greenish tinge. It is highly infectious and will contaminate soil and sometimes fence posts (which goats love to rub against), pens and yards etc. Other goats that contact this material can contract the infection if they have a wound. CLA can also be contracted when goats with lung lesions cough bacteria onto other goats with wounds. In goats, the head is the most commonly affected place and point of entry is through abrasions on the head or in the mouth.

It has been suggested that the high incidence of the infection in feral goats is due to wounds from thorns and sharp branches that were previously contaminated by other infected goats with suppurating lesions, or from contaminated soil entering wounds and abrasions.

It can be difficult to differentiate between an abscess caused by staph bacteria and an abscess due to CLA. It may be a good idea to have your vet send away a sample of abscess material for laboratory testing.

Treatment

We recommend that all infected goats be destroyed and the carcasses burnt. If you do not want to do this, the abscesses should be lanced (opened). You will need the following equipment:

- eye protection;
- gloves;
- 8 × 8 cm cottonwool squares to swab away pus and blood;
- scissors and disposable razor;

- 20 mL syringe without needle, for irrigating (washing out) the wound;
- a bucket of warm water and antiseptic, for washing your hands and arms after the procedure;
- a scalpel;
- 500 mL solution of 6% hydrogen peroxide and water made up as one part hydrogen peroxide to four parts cool boiled water;
- a bucket containing a solution of one part chlorine bleach to four parts water.

If possible, cover the area with sheets of old newspaper – if material from the abscess contaminates the soil, it will remain contaminated for a very long time. If you have a clean concrete floor to work on so much the better, as it is easy to disinfect afterwards.

Immobilise the goat in a headbail or in your usual manner. Wearing gloves and eye protection, clip any long hair away from the abscess and if necessary shave the area using a disposable razor. Taking a square of cottonwool in one hand and the scalpel in the other, hold the cotton square over the top of the abscess and make a horizontal (sideways) incision on the side of the abscess, halfway between its crown and where it meets the body of the goat, at its base.

The incision should be at least 3 cm long because it must stay open so that it can drain for a few days. If the abscess heals before the infection is properly cleared, infection will return. Make sure that you are holding the cotton square over the abscess when you make the incision, because the contents are under pressure and we have seen them spurt more than a metre when released. Abscess contents will contaminate any surface that they touch, including the soil and humans.

After the abscess is emptied using the cotton swabs, syringe the sinus (cavity) with the hydrogen peroxide solution several times. Do this until the solution runs clear and there is no material left in the abscess: Hydrogen peroxide bubbles in contact with pus and blood, so when bubbles stop the wound should be clear of debris.

Wearing gloves and eye protection, syringe the abscess out once or twice a day for the next two days, by which time it should be clean. When it is no longer suppurating, it can be allowed to heal without further interference.

When you have finished cleaning the wound, if possible burn all materials such as swabs, disposable glove etc. If it is not possible to burn them, put them into a bucket and saturate with a solution of chlorine bleach at a ratio of one part chlorine bleach to three parts water. Let the materials soak for at least an hour to ensure that all bacteria are dead. Then seal all waste materials in a waterproof container and dispose of them correctly. However, burning is preferable because it ensures that the bacteria are completely destroyed.

Wash all equipment, including glasses, in strong disinfectant, boil the scalpel handle and dispose of the blade in a sharps container. Your clothing should be soaked in a strong disinfectant for an hour before washing. You should cover your boots with plastic bags to prevent them becoming contaminated and transferring infectious material to soil and shed floors. It is important, when dealing with CLA, to take extra precautions because of the risk of soil contamination and human infection.

We have seen this type of abscess only once, in a feral goat from far western Queensland, where it is a common infection in feral herds.

Two goat owners called us on a Sunday morning and said they had a newly purchased goat that was coughing and seemed ill. They wanted our opinion on whether the vet should

be called. They were new and inexperienced goat owners, so we went to have a look at the doe. We entered the pen, where the doe was headbailed, from the rear and noted immediately that the doe's thigh muscles appeared wasted and that she was extremely thin, with a very poor coat. When we looked at the doe head-on and from the side a large abscess was visible at the top of her neck, just behind the point of the jaw. She then began to cough, a racking, dry painful cough, with her neck extended and shoulders hunched. It was obvious that she was suffering a lot of discomfort and was quite ill.

Given the goat's symptoms and knowing that she was newly captured from a feral inland herd it was possible that she was suffering from CLA (cheesy gland). We explained the consequences to the newly acquired herd if CLA were to spread and suggested that the owners take the goat to the vet as soon as possible. They did so. The goat was diagnosed with CLA and destroyed. The producers revaccinated their goats and spent an anxious few months waiting to see if any other goats were carrying the disease. Fortunately, there were no recurrences. Note: the doe had been coughing and was wasted because there were multiple lesions in the internal organs and lungs.

There are two important things to learn from this example. First, before you purchase any stock – goat or horse or cow – check it thoroughly so that you don't inadvertently bring diseases or parasites onto your property. Second, don't be too embarrassed or afraid to ask for help with a proper diagnosis of a disease or condition. It would have been easy for these inexperienced producers to decide to destroy the goat and burn it without having a proper diagnosis done, but then they would not have known what the problem really was and CLA would probably have spread through the entire herd due to contamination of soil and sheds. They might never have been able to eliminate contamination from the property once it had occurred.

Prevention

The best form of prevention is vaccination. A 1996 study showed that on average, the prevalence of cheesy gland in unvaccinated flocks in Western Australia was 24% per cent and the prevalence in flocks using cheesy gland vaccine without giving two doses at lambing and yearly boosters thereafter was 22% per cent, an insignificant difference. The prevalence in flocks using the recommended vaccination program was 1% (Paton 1997).

The vaccine for the three major clostridial diseases of tetanus, enterotoxaemia and CLA are combined as a single vaccine. In Western Australia, only the three-in-one vaccination is considered necessary (Dept of Agriculture WA). However, in other states there are different conditions that also require vaccination, such as black disease, blackleg and malignant oedema. Because of this many producers use the 6-in-1 vaccines.

Most of the other conditions are not common, so some producers believe that it is only necessary to vaccinate for them when there is a current outbreak. This can often be too late. If diseases such as leptospirosis are endemic to an area, producers will need to vaccinate separately for them.

Other infectious diseases

The number of infectious diseases to which goats are prone is enormous. Fortunately, most of them do not exist in Australia and hopefully, with the vigilance of the Australian Customs Service, the Australian Quarantine Inspection Service and the cooperation of the Australian

public, it will stay that way. Australia's geographic isolation also contributes to its freedom from diseases such as scrapie and rabies, which are endemic in many other countries.

Infectious diseases take many forms and can have widely varying symptoms. Some diseases are zoonotic, which means that they can be transmitted from goats or other animals, to humans. These diseases include tuberculosis (mainly cattle), ringworm (a fungal infection of the skin), leptospirosis, Q fever (Query fever) and CLA, to name just a few. For this reason, producers and other livestock handlers should pay careful attention to hygiene when handling livestock, especially sick stock. Hands should always be washed before eating, drinking or smoking and infective and/or contaminated material burned or disposed of correctly. If you have ever seen anyone with Q fever, you will understand the need for caution when dealing with sick stock.

Other diseases, such as scrapie, can only be transmitted between ruminants that are closely related species such as sheep, goats and deer.

This chapter will discuss only the most common infectious diseases. Further information on these and other diseases can be found online at the web addresses and in the books listed in Appendix 1.

Caprine retrovirus

Caprine retrovirus (CRV, formerly known as CAE or caprine arthritis encephalitis) often used to be called big knee, because it causes swollen knee joints. This is only one of the symptoms, as the symptoms are age-dependent. In kids less than six months old it causes encephalitis, but in older goats it usually affects the joints and can cause pneumonia.

CRV has a long incubation period of several weeks to many months. It is thought to spread through colostrum and can also spread through direct contact. CRV is more common in dairy goats than fibre, meat, or feral goats, perhaps due to shared milking facilities.

Controlling or eradicating CRV is difficult, but can be achieved with persistence. Control programs must take into account the method of spread, the incubation period and the time required before infected animals return a positive blood test.

Blood-test all animals more than three months old to identify infected goats and cull them. If you can't afford to cull goats identified as positive, you will have to run them as a separate herd. And we really mean separate, with double-fencing or solid walls, as recommended by the Department of Primary Industries (Qld). We strongly recommend culling the infected animals.

A control program could also involve snatching the kids at birth – attend the doe during labour and remove the kid before it can suckle. The udder of a forward-springing doe (last week or two of pregnancy) can be covered to prevent the kids suckling if they are born when you are not in attendance. Newborn kids must be washed to remove all blood and mucus, and you should use artificial colostrum or cows' colostrum to rear kids and keep them away from the rest of the herd until they are weaned.

Clinical signs

Symptoms of the disease include:

- in young kids less than six months of age there may be paresis (weakness), head-tilting (torticollis), circling and ataxia developing to recumbency. There may also be fluctuating or constant fever;

- arthritis and swollen painful knee joints. Other joints may also be involved;
- pneumonia that fails to respond to antibiotics and gradually worsens;
- wasting;
- rough coat.

Prevention

There are several important factors in preventing CRV in your herd:

- take extra precautions when attending shows, including checking the CRV status of other goats in the show, i.e. whether they have tested as CRV-free;
- quarantine all new stock and stock returning from shows and agistment;
- check the CRV status of does coming onto your property for service;
- avoid giving kids milk from does whose CRV status is unknown;
- thoroughly sterilise all second-hand equipment;
- when buying goats, check whether they are from a herd whose owner is participating in the CRV accreditation scheme. Very few non-dairy goat owners are, but if the goats have been tested then you can breathe more easily. To learn more about the herd testing accreditation scheme, contact the Department of Agriculture or Primary Industries or your vet.

Treatment

There is no treatment for the disease, and neither is there a vaccine to prevent it. The only way to control the disease is by culling all infected animals as soon as they are discovered and/or rearing the kids in isolation from their dams and running all infected animals separately from the rest of the herd. Despite all these precautions, some kids will still develop CRV.

Leptospirosis

Leptospirosis is a zoonotic disease caused by any one of a group of spiral bacteria known as leptospira. There are many varieties of leptospira and all can cause illness in humans. Leptospira cause disease in many species of animals such as horses, pigs, goats, cattle and sheep. Infection in goats is mainly due to infection with *Leptospira pomona* or *L. hardjo.* Leptospirosis in goats is not common and if a case is diagnosed, the herd should be vaccinated to prevent its spread among the herd and to humans.

Infection commonly occurs when animals come into contact with water and feed that have been contaminated with leptospira from the urine of an infected animal. It may also be contracted from contact with products from the reproductive tract, such as placenta or amniotic fluids containing leptospira. Cattle, pigs and rats are common reservoirs and may carry and spread it to other animals while themselves showing no symptoms – they are carriers of the disease. Leptospiras are shed in the urine long after a sick animal appears to have recovered and this urine is the chief source of infection for animals and humans.

The more surface water present, the greater the likelihood of infection for other animals and humans. The organism survives best at 7–36°C and at a pH of 6–8. It will survive for long periods in stagnant water but will not survive extended very hot and dry periods.

Access to very wet areas or areas with stagnant water should be restricted. In certain high-rainfall regions stock are prone to leptospirosis infection and should be vaccinated.

Our Queensland property is in a very dry area where leptospirosis has not been identified, so we do not vaccinate for it at present.

Clinical signs

L. hardjo is the most common leptospira infecting goats and small ruminants in Australia and New Zealand. Infection with *L. pomona* also occurs; for example, we saw it in a goat herd that had been suffering losses due to leptospirosis in the Gympie region of south-east Queensland. The following symptoms should alert you to a possible outbreak of leptospirosis in the herd:

- abortion – this can have many other causes;
- stillbirths – may have other causes;
- weak lambs and kids – may have many other causes;
- haemoglobinuria (red urine) due to blood cells breaking down and releasing their contents;
- fever;
- jaundice;
- kidney lesions;
- death.

Diagnosis is based on clinical symptoms including fever and pathogenomic haemolytic anaemia. Laboratory diagnosis is quite difficult because the organism is transient in some tissues and may die before the sample reaches the lab. Acute and convalescent blood samples may detect cases of acute disease.

Prevention

Prevention is via annual vaccination. If you bring new stock onto the property, vaccinate them with two doses at a four- to six-week interval. Several companies make vaccines for control and prevention of leptospirosis and their cost is outweighed by stock losses and possible zoonotic infection.

Leptospirosis in humans

Every type of leptospira can cause illness in humans, severe enough for them to be 'out of action' for weeks or months due to the long convalescent period. Clinical signs of leptospirosis in humans include headache, fever, muscular aches and pains, nausea and increased sensitivity to light.

This disease is a real occupational hazard for anyone in the livestock industry, whether abattoir worker or veterinarian. If your job brings you into contact with urine or uterine contents you are at risk of contracting the disease. It is because of the chance of contracting this disease and others from urine, dung, blood, placenta and bodily fluids that we advise anyone assisting at a delivery or attending a sick animal to wear the correct protection – gloves, eye protection and protective clothing. If you suspect that you have contracted leptospirosis you should seek medical advice.

Other diseases and conditions

There are many diseases and conditions that can cause illness, disability and death in goats. This chapter will deal with only the most common.

Abscess

Abscesses can occur almost anywhere on or in a goat. They may be due to infection by the bacterium *Corynebacterium pseudotuberculosis* that causes abscesses of the lymphatic system and internal organs, or one of several other organisms. They can also be caused by grass seeds or other foreign bodies being trapped in a wound, or as a reaction to the adjuvant in vaccines. Most respond to similar treatment but some types, such as wounds from dingo or dog bites, may need antibiotic injections prescribed by your vet.

A simple abscess that is due to a grass seed or similar trapped in a wound can be treated as described above in the section on CLA; others, depending upon the cause and site, need different treatment. An abscess usually takes the form of a swelling beneath or in the skin almost anywhere. The contents usually consist mainly of pus, any colour from almost white to green. The pus has an unpleasant odour and is composed of white blood cells responding to infection or the presence of a foreign body.

An acute abscess feels quite hot to the touch, while an old abscess usually has a more normal temperature and is firm to the touch. When the abscess is on a hairy area, we have more success in treating it if we wait until the hair on the top of the abscess begins to fall out. If the abscess is opened at this time it usually does not return.

Table 9.2 is a quick reference guide to the most common types of abscesses in goats and the best method of dealing with them.

Arthritis

There are several common causes of arthritis in goats. One is osteoarthritis, due to joint damage or simply due to old age. Goats should be culled long before the latter can occur! Incorrect diet that is too high in calcium can also cause problems, especially in confined bucks. One disease with arthritic symptoms is CRV, discussed above. There are other causes of arthritis, however, some seen in kids, does and bucks.

Arthritis in newborn kids

Kids are occasionally born with painful and swollen joints due to mineral and vitamin deficiency; it can be corrected fairly simply. The condition is most commonly seen in multiple births. Treatment consists of half a teaspoon of calcium carbonate and a quarter-teaspoon of cod liver oil daily (Armstrong et al. 1993).

Navel infection, formerly known as joint ill, is due to one of three common bacteria entering the body through the cord because the kidding area was contaminated by dung and dirt or the kid's navel was not dipped in disinfectant at birth. The causative organisms are usually *Corynebacterium pyogenes, Staphylococci* or *Streptococci.* The kid's knees, fetlocks and hocks are usually painful, hot and swollen, and the kid is usually depressed. If treatment in the form of antibiotics is not instituted in the first 24 hours the kid will die; it may die even with treatment. The best treatment is prevention in the form of good hygiene in pens or kidding areas and dipping the navel in buffered iodine at birth.

Arthritis in kids 3–4 weeks of age

Arthritis in kids of this age may be due to mycoplasmosis. Consult your vet for treatment.

Table 9.2 Common abscesses

Type	Cause	Site	Symptoms	Treatment
CLA	Entry of the bacterium *Corynebacterium pseudotuberculosis* into mucus membranes or wound.	Most common on neck at point of jaw or base of neck, udder, groin, lungs and internal organs.	Abscess and, when lungs are involved, cough. Finally (as the condition attacks internal organs) harsh coat, wasting of leg muscles and wasting of body.	Culling and burning any affected stock. If you decide to treat the abscess proper protection must be used: CLA in humans can cause severe illness.
Drenching abscess	Vigorous use of the drench gun.	Mouth or throat.	Difficulty swallowing or chewing.	Seek vet's advice.
Foot abscess (footrot)	Any of three bacterial organisms (*Bacteroides nodous, Fusobacterium mecrophorum* or *Spirochaete penortha*) in muddy ground or wet pasture entering stock via foot wounds; introduction of infected stock from elsewhere.	Feet, usually between the toes.	Separation of the horn from the underlying tissue. Pasty-grey exudate, foul smell and possibly pus and swelling.	Abscess can be drained and cleaned in the usual manner, but seek your vet's advice. Vaccines will prevent this disease.
Grass seed abscess	Grass seed penetrating the body or mouth.	Anywhere on the body or in the mouth.	Swollen lump any size from a few centimetres to grapefruit-size of a grapefruit. Lumpy jaw may occur if infection gets into the jawbone.	Open, drain and treat as for other abscesses. If healing well there is usually no need to call the vet.
Joint abscess (joint ill)	Entry of bacteria through navel if cord not dipped in iodine at birth, or contracted when kids are marked.	Seen mainly in kids' knee, hock and stifle joints.	Joints hot and swollen.	Will need treatment with antibiotics. To prevent it always dab navel with iodine and disinfect instruments properly before and after use.
Spinal abscess	Entry of bacteria through wounds.	Spinal cord. Can result in partial paralysis.	Rear legs collapsing. Animal is depressed and obviously unwell.	Get the vet ASAP because the goat needs antibiotic treatment urgently.
Hypodermic abscess	Reaction to the adjuvant, or entry of bacteria at the site of injection.	Injection site.	Abscess at the site of a recent injection.	If caused by a reaction to the adjuvant or an irritant chemical or medication being injected, it is a sterile (non-infective) abscess. However, if staphylococcus bacteria have entered the injection site the abscess is infectious. Open the abscess, drain it and take the usual safety precautions when dealing with it.

Arthritis in adult goats due to diet

A diet high in calcium with large quantities of lucerne hay can lead to arthritis. It is more often seen in bucks than does, because does are more likely to eliminate excessive calcium in their milk when lactating.

Excessive lucerne has the effect of producing hyperplastic calcitronin cells in the parathyroid gland, which then interfere with the parathyroid hormone and allow too much bone to be deposited. The effects of too much calcium-containing feed can be seen in bucks as young as one year old. They may be severely crippled by the time they are four or five years old (Brown 1981).

Confining bucks in small yards where they have insufficient exercise contributes to the development of arthritis. The amount of lucerne hay fed to confined bucks should be limited and good grassy hay fed instead. You should also harvest and feed browse such as leaves and branches to confined bucks several times a week. They appreciate the occasional piece of citrus fruit (these should be cut in half to avoid the risk of a whole fruit being caught in the throat or mouth and choking the buck).

Beta-mannosidosis

In humans and ruminants a deficiency of the enzyme β-D-mannosidase leads to a lysosomal storage disease called beta-mannosidosis, described as an autosomal recessive inherited disorder. The disease is rare in Australian goats: Anglo-Nubians are most often affected and there have been several occurrences among Saanens. Cases have been recorded in Australia, New Zealand, Fiji, the US and Canada (Baxendell 1988; Vindish 2002; Jones and Dawson 1981). When two carriers are mated, their kids have a 25% chance of developing the disease (Baxendell 1988).

The condition is caused by lack of the enzyme β-D-mannosidase that normally removes certain sugars (mannose and N-actylglucosamine) from the cells. This genetic defect means that kids lacking in this enzyme will die, due to the build-up of sugars in the cells. Blood tests will show that the carrier parents have only half the normal amount of β-D-mannosidase in their blood and the affected kids have almost none (Baxendell 1988).

The most obvious symptom is legs that are bent at the knees and cannot be straightened. If you try to straighten the legs, it seems as if the tendons are too short to allow it. The kid appears to have cerebral palsy and is shaky and unable to stand or hold up its head. It will suckle if held up to the nipple but rapidly weakens and, despite all effort, dies at around 10 days of age. There may also be skeletal deformities, twitching eye movements and deafness (Vindinsh 2002). The only good thing about the early death is that the condition is self-limiting: the kid does not survive to breed or be inadvertently sold to another unsuspecting breeder.

We suggest eliminating carriers no matter how outstanding they are. The condition occurred in a kid born to a feral dam and an Anglo-Nubian sire from an Australian national champion line, whose sire sold for $23 000. He was still culled!

Breed societies in Australia have worked for many years to eliminate this inherited condition from the national herd and must be commended for their time and effort.

Big head

This condition is seen in bucks just prior to and during the mating season when they are prone to fighting. Much headbutting, pushing and shoving occurs between bucks in their rivalry for the affections of cycling does and bucks often receive small wounds and abrasions at the base of their horns, that permit entry of clostridial bacteria. Big head is generally caused by *Clostridium novyi*, the bacteria that causes black disease, but may be due to infection with *C. oedematiens* (Baxendell 1988; Brown 1981).

Clinical signs include:

- oedema near the base of the horn or horns, which spreads to the eyes, the head and finally the neck;
- fever;
- grinding teeth due to pain;
- inflamed mucus membranes in the eyes and mouth;
- no appetite;
- obvious lack of health.

It is imperative that the vet be called to treat the affected buck, or you will almost certainly lose the animal. Antibiotics are required, usually high doses of tetracycline or penicillin. A spray-on antiseptic dressing that includes fly-repellent (ask your vet) should be sprayed on the wound area to prevent flystrike. We have seen goats driven almost to distraction by maggots infesting wounds in the head area.

If the condition is due to infection with *C. novyi*, vaccination usually prevents a recurrence in future breeding seasons. Isolating the bucks well away from the does until they are to be joined is probably the best way to prevent fighting, but is not always possible due to constraints of fencing or property size.

Bloat

Goats often become bloated after being fed large quantities of lush green feed to which they are not accustomed. We have seen this condition in a herd of goats during severe drought, after they were fed fruit and vegetables that had been kindly donated by a local farmer. The goats had not had any fresh feed for months and gorged themselves, resulting in a number of very sick goats that had to be treated for a severe case of bloat. However, it is most often caused by goats gaining access to a lucerne crop or other unaccustomed lush grazing such as clover or cereal crops. All of these can also cause other severe health problems, such as enterotoxaemia or impaction. Goats suffer bloat less often than cattle or sheep do.

The symptoms of bloat are due to gas bubbles distorting the rumen and usually consist of the following:

- the left flank is taut and distended and sounds like a drum when tapped;
- the goat is obviously in a great deal of discomfort, stamping its feet, bleating and making frequent attempts to urinate (Brown 1981);
- the goat walks with a stilted action (Brown 1981);
- it collapses onto its side, with laboured breathing.

This is a medical emergency and unless treatment is given to break up and disperse the trapped gas bubbles the goat will die, often within 30 minutes. The traditional treatment of

puncturing the animal's side to let the gas out is rarely used now because of the risk of infection. The treatment most often used is as successful as the more traditional method, but is much safer and less painful for the animal.

Treatment is aimed at breaking up the bubbles that form foam on top of the ruminal contents. The foam presses against the diaphragm, interfering with breathing and putting pressure on the heart and will rapidly kill the animal if it is not dispersed quickly. There are properly formulated bloat oils, but if you do not have any then edible oils such as olive, sunflower, canola, maize or peanut may be used instead. Never use strong-tasting oil such as linseed oil.

The oil should be carefully syringed into the goat's mouth or introduced directly into the rumen via a stomach tube. In kids up to four months of age, 25–50 mL should be sufficient. For an adult goat, we give 120 mL directly into the rumen via a stomach tube. The vet will usually teach you the technique; if not, slowly give the oil directly into the mouth. If you inadvertently get oil into the lungs, it will often kill the goat. Roll the goat from side to side after the oil is given, to disperse it evenly in the rumen. It is a good sign if the goat belches repeatedly. If there are no other physical or health problems the goat will soon be back to normal.

To prevent bloat:

- limit access to large quantities of unaccustomed lush feed or fruit and vegetables: dumping a truckload of tomatoes in front of a herd of hungry goats is asking for trouble;
- introduce new feeds gradually;
- shut gates to deny access to lucerne and cereal crops.

Cancer of the skin and external mucus membranes

Several types of tumours occur in goats, but the most common are skin cancers due to the combination of Australian climate and the lack of pigment in light-skinned goats. These cancers are especially common in Saanen dairy goats. Some breeds, such as the South African Boer goat from the sunny climate of South Africa, have been selectively bred for dark pigmentation of exposed skin to lessen the problem of skin cancer.

These sun cancers mostly occur on the exposed areas of the nose, ears and vulva of affected goats, but may also be found as squamous cell carcinomas on the periocular skin of the eyes or third eyelid (with eye cancers, consult your vet).

Some small cancers can be removed and some, such as those on the ears, appear only in older goats and often progress quite slowly. They may look unsightly but seem to cause little problem. Vulval cancers are not in that category and some light-skinned goats such as Saanens appear to be particularly vulnerable.

Vulval cancer usually begins as a small raw red patch, which rapidly becomes an unsightly and painful growth. A vet can treat the cancer in its early stages but it usually returns. The best solution appears to be culling of affected lines and selective breeding for pigmentation on exposed areas of skin. This can be achieved by introducing South African Boer or Anglo-Nubian bloodlines, as both have pigmentation on areas of exposed skin.

Our experience with this condition suggests that it may be heritable, because it appeared in one particular line of cashmere goats that had been selected over a number of years for their fine white down. They had a total lack of skin pigment but were not albino.

Five of the does developed vulval cancer. We have culled this line of goats, all of which had Saanen ancestry.

Capture myopathy

The stress of transport or the yarding of wild animals, including feral goats, can precipitate this condition, also known as exertional rhabdomyolysis (Thomas 1981; MLA & Livecorp 2001). Stress causes an overwhelming build-up of lactic acid in the muscles, which often results in death.

Losses of feral goats during transport over long distances can be as high as 25%. The disease causes muscle degeneration and kidney damage; goats that survive may succumb to kidney malfunction.

- Do not use dogs to yard feral goats and handle them as quietly as possible.
- Stop to allow the goats to drink if the journey is long – you will have to plan these rest stops well before you intend to transport the animals. If you are sending the goats to market with a transport company discuss this with them, as they know where there are yards and watering facilities on transport routes.
- Transport goats at night in hot weather to reduce heat stress and moisture loss.
- Give electrolytes in drinking water prior to transport to help stabilise their blood pH, replenish electrolyte loss and prevent dehydration. Maintaining a constant neutral blood pH is vital in preventing losses during transportation. There are many brands of electrolyte replacements and those suitable for sheep are also suitable for goats. The ingredients usually consist of sodium bicarbonates, potassium and sodium chlorides, dextrose or glucose and sometimes vitamin A.

Conjunctivitis

One of the most common forms of conjunctivitis (inflammation of the conjunctiva, i.e. the inner lining of the eyelids) is a condition called keratoconjunctivitis, also known as pink eye. The condition occurs in both sheep and goats. The causative agent is disputed, but may be any one of several different bacteria. It can be contagious, so wear gloves when treating an affected animal. Your vet can prescribe antibiotic drops for treatment, but may instead prescribe the antibiotics as an eye ointment because it is not blinked away as readily as drops.

Before instilling the drops or ointment, put on gloves and eye protection and bathe the goat's eyes with sterile saline solution at body temperature (39–40°C). You can purchase saline at a pharmacy or make your own by dissolving a quarter-teaspoon of salt in 500 mL of sterile water (boiled for 15 minutes, then cooled). Immobilise the goat and use a cotton swab dipped in the solution to bathe the affected eye. Always begin at the inner corner of the eye and wipe to the outer corner. This will avoid transferring infection from the infected eye to the good eye, as you are wiping away from the good eye. Do not dip the used cotton swab back into the solution after each wipe – discard it and use a fresh swab to repeat the procedure.

When you have removed all the discharge, put in the drops. Gently hold the eyelid shut for a few moments to allow the drops to cover the eye properly before the goat blinks them away. If you are applying ointment, pull out the lower lid gently and run the ointment along

the inside of it. Hold the eye shut for a few seconds. Burn the used material such as swabs and disposable gloves, as they are infectious.

Foreign body conjunctivitis

This occurs in goats that have been grazing among seeding grass. Goats can also get a seed in the eye from their hay ration. Symptoms are similar to those of keratoconjunctivitis and you must examine the goat carefully to decide which condition it has. If you examine the affected eye and cannot see an offending seed, there are two possibilities: there is no seed (keratoconjunctivitis) or there is a seed but it is trapped behind the third eyelid. If there is a trapped seed the goat must be sedated by the vet before the seed is removed.

A third cause of foreign body conjunctivitis is grit, such as dirt or sand, trapped in the eye. This is easy enough to remove but it can scratch the surface of the eye. The vet will need to treat the goat to prevent blindness due to corneal scarring.

Conjunctivitis is also a symptom of other diseases such as leptospirosis and melioidosis or can be part of a range of symptoms in certain vitamin and mineral deficiencies, such as cobalt (B12) or vitamin A deficiencies.

Coughing

There are several possible causes, some of which are quite harmless, such as when a goat cuds. Most goats are fairly discreet when cudding; you might notice a goat give a gentle burp and then contentedly chew its cud. This is not always the case, however, as some are quite noisy about the process and cough loudly before beginning to chew the cud. If the goat has no other symptoms, such as lungworm eggs in the faeces when a faecal egg count is done or fever, unexplained weight loss and so on, it is probably just cudding. If you are concerned, the vet can examine the goat.

Bronchitis

The goat may be suffering from bronchitis caused by too much dust in the feed or because the feed has been given in a narrow container such as a bucket, which doesn't let the dust escape. When goats are fed in feed troughs or on the ground, the wind blows away the fine particles before the goats can inhale them.

Very dusty feed should be dampened to reduce the amount of dust. Do not dampen more feed than will be eaten in one day because it can ferment, especially in hot weather, allowing mycotic fungi to grow. These fungi can cause major health problems because they produce a toxin that may kill the goat by destroying the liver and heart.

Coughing can also be due to mycoplasmosis or lungworm infection. Laboratory tests will be necessary to confirm a diagnosis of mycoplasmosis and the laboratory will need to do a faecal egg count and culture to identify lungworm infection.

Diarrhoea

Diarrhoea in kids

Diarrhoea can occur in kids due to a number of causes including incorrect feeding and bacterial infections from poor hygiene practices, either by the owner or because kids sometimes taste everything including dirt (just like human kids). Dietary diarrhoea can result from giving kids calf-milk replacer, that contains tallow. The kids' digestive system

cannot handle this and profuse watery diarrhoea is the result. Another dietary cause is substituting skim milk powder for full-cream. Goat kids can go straight on to full-cream goat or cows' milk once they have had at least two days of colostrum. Natural colostrum is preferable because it contains antibodies.

Another cause is 'killing the kid with kindness' – overfeeding. A doe seems to know instinctively when her kids have had enough to drink and will move away; if the kids persist in trying to suck she will even run away! Concerned owners who are handfeeding kids sometimes feel that the kids should have as much milk as possible, in the mistaken belief that they will do better and grow faster. Forcing more milk than the kids can drink comfortably in 10 minutes or so often results in diarrhoea and even death. More is not necessarily better.

Simple dietary diarrhoea in young kids up to six weeks old can be treated with two teaspoons of kaopectate initially, repeated every two hours until the diarrhoea ceases. If the diarrhoea has continued for even a short while the kid may be dehydrated; drenching every six hours with 80–120 mL of glucose and water, with a tiny pinch of salt, can help to rehydrate the kid. These simple measures, plus a change in diet, should correct the problem.

Colibacillosis

This condition occurs in kids under four weeks old and is caused by a type of enterotoxagenic *E. coli*. We have seen this condition in a four-day-old kid. Clinical signs include profuse whitish-yellow scouring that smells 'off', the kid's ears and mouth etc. may feel cold to the touch, there may be dehydration and, finally, death. Take an affected kid to the vet as it will require antibiotics and rehydration. The vet may also do some tests to identify the causative organism.

Salmonellosis

This disease is caused by *Salmonella* spp. Clinical signs include profuse yellow watery diarrhoea that may or may not contain blood (dysentery), dehydration, fever, depression and death. The vet will prescribe antibiotics, rehydration and perhaps laboratory tests to identify the bacteria.

Keep ducks, which often carry the organism, away from stock's drinking water. Ducks wash their food before eating and thus transfer the salmonella organisms to the water; stock drinking this water may then become infected.

Diarrhoea in adult goats

In adult goats, diarrhoea can be caused by dietary problems, bacteria or intestinal parasites. Dietary diarrhoea is often due to sudden changes of diet. These may include such things as unrestricted access to lush pasture for goats that are not used to it, feeding large quantities of fruit, vegetables or bread, or goats helping themselves in the feed shed when a door is inadvertently left open. Faulty feed rations may also cause the condition.

The only clinical sign is the diarrhoea; goats will not have fever nor be depressed. Treatment involves correcting the diet by:

- giving good-quality dry grassy hay before allowing the goats into lush grazing;
- shutting that feed shed door;
- severely limiting the amount of fruit and vegetables;

- increasing the goats' access to browse. Cut branches of shrubs and trees if necessary;
- giving only concentrates formulated for goats and not those formulated for cattle, even though cattle rations are usually less expensive.

For severe diarrhoea, dehydration can be avoided by giving one tablespoon of anti-diarrhoea mixture every two to four hours until the diarrhoea stops. If the goat becomes dehydrated, give 200 mL of cool boiled water in which one tablespoon of glucose, honey or sugar has been dissolved, three or four times per day (or a commercial electrolyte replacement from the vet or feed store).

Infectious diarrhoea can be due to any of a number of bacterial organisms and goats may die even when treated. One organism is *Clostridium perfringens,* which is the cause of enterotoxaemia. This bacterium is always present in the gut but problems arise when it breeds too rapidly and produces a toxin which can cause severe illness and even death.

Adult goats can suffer from salmonellosis, which requires veterinary treatment.

Entropian

Entropian is mainly seen in young kids – the eyelashes, usually the lower lashes, turn in and irritate the eyeball. The eye becomes red and inflamed, allowing entry of bacteria. The kid looks like it is suffering from pink eye and the infection can indeed be due to one of the bacteria believed to cause pink eye.

Treatment is with antibiotic eye ointment or drops for the infection and the gentle mechanical turning out of the lashes several times a day to encourage them to grow outwards in the normal direction. This is usually successful, but if it is not surgery will correct the condition.

Fractures

Goats often suffer fractures from falls, fighting, catching a leg in the mesh of a fence and so on. A fractured foreleg in bucks is quite common because, when fighting over females or even just 'play' fighting, a leg can be trapped between an opponent's horns. In an effort to rid itself of the leg trapped between its horns a goat will twist and pull away, usually fracturing the trapped leg. The vet will need to set the leg. If the fracture is a major one on the hind leg, it is unlikely that the buck will work again; it will probably need to be destroyed.

Kids often suffer a greenstick fracture due to misadventures when playing. You may see a kid limping around, holding up one leg and looking quite sorry for itself. You will often find a swelling over the bone, which the kid will resent you touching. Have an assistant hold the kid and, holding your fingers and thumb around the swelling, take the hoof in your hand and **very gently** move the leg a few millimetres. If you hear or feel grating, the limb is fractured. In very young kids the bone is quite soft and the fracture is a 'greenstick' fracture, where the bone is not broken all the way through. If you are certain that the fracture is not displaced, the limb can be splinted. In our experience, a student's thin wooden ruler cut in half serves the purpose admirably. We pad the leg with a length of cottonwool wadding, place the two pieces of ruler over the padding on either side of the fracture and bind with Elastoplast®. The fracture should heal nicely in three weeks and the splint can be removed. Don't bind the splint too tightly because that can cut off the circulation; too loose and it will

not stay in place. The splint should not be long enough to touch the ground. Check the splint daily to ensure that it is not too tight and that is it still in place.

If the fracture is complete, severe or compound (the bone is exposed or has broken the skin) you must call the vet, because it will need professional attention. Compound fractures often cause serious infections resulting in the death of the injured goat, and a displaced fracture that is not set correctly can cripple the animal.

Fractures in goats more than a few months old require a vet. The consequences of amateur attempts at reducing and setting a fracture can be a crippled animal (because the bone is not set correctly), a haemorrhage when shards of fractured bone pierce an artery, or a compound fracture when the ends of the bone break the skin during attempts to reduce the fracture.

The cost of professional treatment for fractures is often more than the value of the animal, so take this into account when deciding whether to treat or destroy the animal. It is often more economical to destroy an animal with a fracture than to treat it. This is solely a management decision for the producer.

Impaction/indigestion

The condition is sometimes due to a goat getting into the feed shed or gaining access to rations meant for other types of stock, but more often it is due to the feeding of inappropriate foods such as bread, pollard, bran or less expensive but poorly formulated rations that contain too much indigestible fibre. These types of feeds cause the rumen to become packed with a soggy indigestible mass of material which begins to ferment, causing great discomfort or even death.

Impaction can also result from drenching the goat with strong-tasting oils, such as linseed or castor oil. These are very unpleasant-tasting so the goat will often refuse to cud, resulting in impaction or indigestion. As discussed in Chapter 7, to digest cellulose for energy a goat must cud and chew feed again after it is swallowed, so that it can be broken down and digested by the rumen bugs.

Clinical signs include:

- the goat is depressed, stands around and may kick at its abdomen;
- droppings are flinty, small and often foul-smelling and may have mucus on them;
- inappetence (lack of appetite);
- reduced milk production in lactating does.

It is necessary to remove the accumulated material in the rumen if the goat is to survive. Brown (1981) recommends doses of Epsom salts (often with added Dettol) – 120 g, 80 g, 60 g and 30 g on successive days. He also recommends doses of 120 g Mylanta three times a day, to neutralise excessive fermentation. We give goats a teaspoon of bicarbonate of soda in 50 mL of water twice daily for this. The treatment is repeated for the next two days after which the goat is usually well again, although its appetite can take some time to return.

A dose or two of probiotics, obtainable from your vet or feed store, can help to establish the gut flora, as can obtaining some cud from another goat and force-feeding it to the recuperating goat. Watch your fingers both when obtaining the cud and when feeding it: those teeth are like razors! A small tub of yoghurt will also help re-establish gut flora.

When a goat has been suffering from a severe impaction of the rumen it may have a depressed appetite and not want to start eating again. You will need to force-feed fresh leaves such as wattle, mulberry, citrus and blackberry to stimulate its appetite. Once again, watch those fingers. It may be necessary to force-feed fresh feed for three to four days, as the appetite is sometimes quite slow to re-establish after an illness. We usually give the goat injections of injectable vitamins A, D, E, B12 and iron after an illness such as this, because it seems to bring them back into condition faster. A molasses drink made by dissolving a quarter-cup of molasses in 1.5 L of water can help to stimulate the appetite and a slice of watermelon is also appreciated, as goats are very fond of it.

If the goat is lying on its side, it must be propped up. It is especially important to do this as soon as possible if a goat is lying on its left side, because that position will cause the rumen to collapse and the goat will die. Hay bales are very useful for propping goats into a sitting position, resting on their brisket (chest) and back legs. We put one front leg forward and bend the other front leg at the knee into a comfortable position. Because the goat is not moving around we usually cover it with a chaff bag or similar, especially in winter, so that it does not become chilled.

If the goat is down for any length of time you will have to raise it in a sling for an hour at a time, two or three times a day. If the goat is lying down and taking no weight on its legs for long periods, the legs will lose function. If a goat is down for more than 24 hours it may not be able to rise to its feet again without help and will need to be destroyed, as it will continue to deteriorate and eventually die.

We have found that a sling made from a 40 kg feed or fertiliser bag does the job well. For bucks you will need two bags folded in four lengthwise, with one going across the body in front of his rear legs and the other behind the front legs; the testicles and penis must not be covered. The ropes are tied to the roof then the sling is put under the animal and slowly raised to a height that allows the goat's feet to just take its weight. Be careful not to raise the sling too high or the goat may slip out of the sling and be injured; the feet should be able to rest flat on the floor.

Johne's disease

Johne's disease (JD) is caused by the bacteria *Mycobacterium paratuberculosis.* This bacterium causes the intestinal wall to thicken, thus preventing the normal absorption of food. The disease occurs in two forms in Australia: bovine Johne's disease (BJD) and ovine Johne's disease (OJD). Johne's disease was first described in 1895 in Germany by the veterinarians Johne and Frothingham. It was first diagnosed in cattle in Australia during the mid 1930s and in sheep during the mid 1980s. Johne's disease was first diagnosed in goats in Australia in 1977, in five goats in Victoria (Baxendell 1988). In early 2004 there were 646 sheep flocks, 1348 cattle herds and 30 goat herds known to be infected with JD (Animal Health Australia 2004).Although most of the infected flocks and herds are in south-eastern Australia, infection has been detected in all states except Queensland and the Northern Territory. Johne's disease is a notifiable disease in Australia. If you suspect it may be present in your herd, you should immediately inform the local stock inspector or Department of Primary Industries or Agriculture.

The BJD strain of bacteria is more often found in cattle and the ovine strain tends to occur in sheep and goats. Cross-species transfer has been recorded in a small number of

cases – Johne's has been found in a small number of kangaroos and wallabies, the significance of this is still being investigated (Animal Health Australia 2004).

Bacteria from infected animals are passed in the dung and in cool moist areas may survive more than a year. Hot dry conditions may reduce the survival period. Other animals ingest the bacteria when they graze contaminated pasture or drink contaminated water.

There is no known treatment for infected animals. Eradication on infected sheep properties has been attempted with only limited success; it involved destocking for 15 months, including two summers. Johne's disease is incurable and all infected animals that are not culled for slaughter or die from other causes eventually succumb to its damaging effects in the gut, and die.

Clinical signs include:

- severe wasting, even though the animal may have a good appetite. The goat becomes emaciated over a few months (even when there is ample feed) while others in the herd may be in good condition (this can be a sign of other conditions or diseases, for example protein or energy deficiency, internal parasite infestation or a trace element deficiency);
- rough coat (this can also be a sign of other conditions and diseases);
- lagging behind the mob;
- diarrhoea usually does not occur.

In sheep:

- 65% of infected flocks have a death rate of 1–4% associated with OJD;
- 25% of infected flocks have a death rate of 5–7%;
- 10% of infected flocks have a death rate of 8–15% (Roberts et al. 1998).

National Control Program

The National Johne's Disease Program is a cooperative program involving Australian livestock industries, governments and the veterinary profession. Animal Health Australia coordinates the program on behalf these key stakeholders (Animal Health Australia 2001).

Because Johne's disease is not obvious in young animals it may spread to many other animals in a herd before it is diagnosed. It can spread to other herds on nearby properties by contamination of waterways, or straying of infected stock. It may spread further afield when infected animals are transported for sale or agistment. Because the number of infected flocks of sheep and herds of cattle and goats was increasing, it was necessary to formulate a national plan to control the spread of JD and eliminate this potentially economically devastating disease.

Johne's disease is presently restricted to temperate south-eastern Australia, diagnosed in 30 herds of goats in early 2004. This is not a great number, but it is 30 herds too many. It is hoped that the number of JD-infected herds can be reduced significantly with the cooperation of producers, vets, the livestock industry and the national control plan.

Zoning and JD

Zoning is used worldwide to control the spread of infectious diseases. Different areas of an area or region are placed in different zones according to their risk of infection. National zoning for OJD and BJD was introduced in 1999. Zoning classifications were based on:

- the prevalence of the disease in each region;
- the measures in place to detect and control the disease in that region.

For an area or region to change its status, approval is needed from the national Animal Health Committee, which consists of the Commonwealth Chief Veterinary Officer and the Chief Veterinary Officer of each state and territory.

Movement restrictions and zoning are subject to change at any time, so when moving stock from one zone to another it is essential to check for up-to-date information from the Department of Primary Industries or its equivalent.

GoatMAP

The most common way that Johne's disease enters a herd or flock is through the introduction of animals from an infected herd or flock. GoatMAP provides the best available assurance of low disease risk. The GoatMAP is a national scheme where owners voluntarily submit their stock to a testing program and adopt a higher level of management to minimise the risk of disease introduction. With negative test results and appropriate management, the herd is given the status of monitored negative (MN). This does not guarantee that the herd is free of Johne's disease, but the higher the status of a herd the greater is the assurance that the herd is not infected.

MN1 is the lowest status, but provides greater assurance than a herd whose status is unknown. (herds of 'non-assessed' or NA status). MN3 is the highest status. It is generally achieved after a herd has been in the scheme for at least four years. An annual veterinary audit, including testing, gives further assurance that the herd is not infected with Johne's disease. Testing is arranged through your vet and usually requires a blood sample and faecal sample for culturing from each animal. In some states, the cost of testing may be covered by state programs.

Vendor declaration

The vendor declaration is a signed declaration by the vendor or agent that to their knowledge there is no reason to suspect JD is present in the herd of origin, or on any land on which the goats have ever grazed. It includes a description of the stock and the level of testing, if any, undertaken in the herd (Geoff Murray pers. comm. 2003).

Vaccination

Gudair® vaccine, which is a killed-type vaccine, is the only vaccine registered in Australia for the control of ovine Johne's disease in sheep and goats. The Gudair® vaccine has been shown to reduce the level of clinical disease and mortalities, as well as delaying and reducing the shedding of OJD bacteria in faeces. The vaccine is most effective if administered before goats are exposed to the disease. It is recommended that kids be vaccinated before they are 16 weeks old.

A 1 mL dose of the vaccine is administered by subcutaneous (beneath the skin) injection high on the neck, just behind the ear. Injection-site reactions are not uncommon with this vaccine.

Caution: be extremely careful that you do not accidentally inject yourself with the Gudair® vaccine, because it can cause a severe and persistent reaction. The immediate reaction to self-injection is severe pain, swelling and inflammation. If the needle-stick injury is not opened and drained by a medical practitioner as soon as possible, a painful

reactive granuloma may develop in response to the continued presence of the oil-based adjuvant. You must get medical advice (Dr Ross Henderson, CSL, pers. comm.).

Any leftover vaccine must be disposed of as described on the label and must not be supplied to another person for use on a property other than that specified on the authority.

In Tasmania and New South Wales, vaccinated stock must be identified with a National Flock Identification Scheme V tag, at the time of vaccination. These tags bear the property identification code of the property (which is the same as your cattle tailtag number) and a V to indicate the animal has been vaccinated. However, because every state has its own regulations relating to vaccination and identification of vaccinated stock, you should check this with the government veterinary officer.

The solution to the control and/or elimination of Johne's disease cannot rest with vaccination alone, and vaccinating stock for Johne's disease creates its own problem. Animals vaccinated with the Gudair® vaccine develop antibodies in response to the vaccination which helps to protect them from OJD, but it also means that any vaccinated animal will return a false-positive result to testing. This is the reason why animals that have been vaccinated for Johne's disease in Tasmania and New South Wales must carry an NFIS V tag to allow them to be identified.

A final word on OJD:

- it is the owner's responsibility to inform buyers and transporters of the stock's status and to ensure that it is protected;
- buyers of replacement breeding stock should request a signed JD vendor declaration;
- always check zoning and movement regulations before moving goats off property.

For further information on this disease visit the Animal Health Australia website at http://www.aahc.com.au and follow the links, or contact the Department of Primary Industries or Agriculture.

Mastitis

Infection of the mammary glands is common in lactating mammals including goats, especially high-producing dairy goats (Baxendell 1988; Guss 1992; Brown 1981; Ingalls 2003; Shurley 1998). There are three recognised types of mastitis, all equally contagious. The three types are retroviral, mycoplasmal and bacterial mastitis, which is probably the most common. The usual precaution of isolating infected stock should be followed.

Though stock appear to be cured they often become carriers of the causative organisms and it is best to cull a doe that has had mastitis, especially staphylococcus or streptococcus infections; a tough decision but one that will make life easier in the long term. Discuss the advisability of culling affected animals with your vet.

Clinical signs of mastitis include:

- an udder that feels hot, tense and dry. It may feel as hard as a brick in some areas and be shiny and swollen with a flaky and patchy appearance. This is difficult to describe, but once seen will not be forgotten;
- a doe will resent you touching her udder because it is very painful and she may cry in pain when you attempt to milk her;
- milk often contains clots and sometimes blood;

- in severe cases, the milk separates into liquid and curds. The fluid obtained when milking is watery and contains clots of white curds large enough that it is difficult to milk them from the teat.

The condition is precipitated by the entry of the causative organism into the udder, usually via the teat but sometimes via the bloodstream (as in a mycoplasmal infection). Entry via the teat can result from the doe having a long pendulous udder whose teats drag on the ground and contact contaminated soil. Organisms can also be introduced by contaminated milking equipment, but this is not normally a problem in meat goats.

Mastitis can be caused by poor hygiene when owners remove the plug of waxy material in the teat after kidding. A newborn kid has a clean mouth; dirty fingernails are a bad idea. Attention to hygiene when handling the teats and udder can help prevent mastitis.

For treatment, isolate the doe and call your vet. The vet will take samples of milk and arrange for a laboratory to determine the causative agent, and prescribe a broad-spectrum antibiotic to treat the condition. Treatment often includes a series of antibiotic injections and the insertion of an antibiotic directly into the udder via the teat.

The udder will need to be thoroughly stripped out. Getting another person to help is useful because the doe often tries to move around and kick, as the udder is so painful. To strip the udder you will need gloves, eye protection, a milking bucket, a bucket of warm water (45–50°C, hot to the hand but not uncomfortably so) and disposable cloths or clean rags for washing the udder.

Immobilise the doe in a headbail or tie her head. Use the cloth to wash the udder, holding it on the infected area for a minute to allow the soothing heat of the water to relieve some of the tension and pain. After a minute or two the doe discovers that the warmth of the water is soothing and she will usually permit you to apply the warm cloth without further struggle. Rinse the cloth in the warm water to reheat it and repeat the procedure several times for five minutes, concentrating on the worst-affected areas. This will help the milk to flow and make it easier to strip the udder completely.

When you have finished washing the udder, strip it out completely. The doe will resent this because it is extremely painful and your assistant should make sure that the doe cannot kick you.

It can be helpful to massage the udder with an old-fashioned liniment made from half a cup of pure soapflakes dissolved in 600 mL of boiling water and cooled. When cool, add two tablespoons of eucalyptus oil. Shake well and use two or three times a day (Brown 1981). Keep this away from your eyes!

Gangrenous mastitis

This is a serious condition and the vet must be called as soon as possible or you will lose the animal. Causative organisms may enter through the teat, but mechanical injury to the udder can also allow entry. In the latter case, there is no time to be lost before treatment is commenced, because the disease progresses very rapidly.

Clinical signs:

- the animal is down;
- there are cold extremities – ears and legs;
- the area around one teat or one half of the udder is cold;

- a demarcation line forms, with the affected area turning blue then purple;
- the doe is obviously in a lot of pain, grinding her teeth or crying out;
- milk is watery, consisting mainly of serum and possibly blood, pus and large clots of milk curds. It is foul-smelling;
- if the infection is not treated or cannot be halted the whole of the infected hemisphere will slough off. The kindest thing is destruction of the doe and artificial feeding of her kids.

The vet will prescribe antibiotics and you should follow the instructions for treatment. They usually carry out tests to determine the causative organism and often surgically remove the affected area to halt the spread of the gangrene. Frequently, the affected hemisphere is so damaged that it is incapable of producing milk. Kids of does that have recovered from any type of mastitis should be watched to ensure that they are receiving adequate nutrition.

The doe will need to be checked in the following kidding seasons to ensure that she is producing enough milk for her kids and not developing mastitis again – once does have had it they are prone to develop it again. Any kids from an affected doe need to have milk supplements until they are old enough to be weaned. We recommend that the doe be culled.

Gangrenous mastitis is aggressive and progresses rapidly. The earlier that treatment is begun the more likelihood there is of a successful outcome for the doe and her kids.

Melioidosis

Melioidosis is found in tropical regions of Australia and in south-east Asia. The causative organism is *Pseudomonas pseudomallei* that is found in soil and water. The condition causes multiple internal and external abscesses and is generally fatal.

The condition can be mistaken for caseous lymphadenitis because of the abscesses in the external lymph nodes and the udder. In some regions it is endemic and it has been isolated from soil and water in areas such as Townsville in Queensland. In any region north of the Tropic of Capricorn, melioidosis should be suspected if a goat has such abscesses. Symptoms and disease progression are related to the site of infection and the dose of bacteria received. Affected goats have often been grazing flooded pasture or their water supply may be contaminated (Baxendell 1988).

Suspect melioidosis infection if the clinical signs are:

- abscesses in external lymph nodes and sometimes the udder;
- dyspnoea (laboured breathing);
- septicaemia;
- fever;
- purulent nasal discharge;
- coughing;
- mastitis;
- lameness.
- chronic wasting with abscesses in the lymph nodes and udder

Call the vet if you suspect that a goat in the herd could have this condition. Your vet will do some tests and a post-mortem to determine if the disease is indeed melioidosis. If you

are assisting at the post-mortem, wear protective clothing, gloves and eye protection, because this disease is zoonotic (can be transmitted from species to species) and can cause severe illness or death in humans.

A post-mortem will show encapsulated abscesses in the lungs, internal organs and lymph nodes. The vet will take samples of these for culturing. A sporadic disease as animal-to-animal transmission is rare (Baxendell 1988).

Mycoplasmosis

Mycoplasmosis is the most common form of pneumonia in goats in the US, and is more common there than in Australia. The disease in goats is generally caused by *Mycoplasma mycoides subsp mycoides*. There are many different strains of mycoplasma bacteria, 55 at last count, one of which (contagious bovine pneumonia) caused massive stock losses in the US in the 19th century (Ayers et al. 1992). Several strains also affect humans and some varieties infect birds, pigs, cats, dogs and many other species.

In goats, the disease occurs mainly during spring in kids 2–10 weeks of age and can cause heavy losses.

Clinical signs include:

- swollen carpi and stifle joints (front and rear knees);
- coughing, especially if forced to exercise;
- lung involvement, always on the right side and sometimes on the left;
- abscess in the lung, containing pus;
- mastitis in dams that may also develop pneumonia and polyarthritis;
- death.

In Australia a herd outbreak can be controlled by treating the dams with tylosin (Tylan) and feeding the kids pasteurised milk – not all kids respond to tylosin and those that don't may become chronic carriers (Baxendell 1988). We strongly advise discussing the latter possibility with your vet before treating kids with tylosin. Tylosin is not registered for use in goats to be sold in Australia so it may be a good idea to discuss the export-withholding periods if it is used in stock intended for export to the US, with the Department of Agriculture or Primary Industries, or your vet.

Ringworm

Ringworm is a fungal infection of the skin that is often caused by *Trychophyton verrucosum.* It is highly contagious and no species is immune, including humans. It is spread through contact with infected animals or people.

Clinical signs include evenly shaped patches of missing hair, sometimes with the hair broken off short. There may be crusting or flaking. These patches can be anywhere on the goat's body, legs or face and will spread if not treated.

Excellent antifungal preparations are available through your vet or rural suppliers. Sometimes, treating the infection with buffered iodine daily for 10 days will clear the infection. Any goat with ringworm should be isolated from the herd until the infection is gone.

Shock

This is a term used to describe life-threatening, physiological response to such things as injury, severe pain, dog attack, insect stings, haemorrhage, infection or the administration of certain drugs and vaccines. Shock causes blood vessels to dilate, leading to a drop in blood pressure and the subsequent inability of the heart and circulatory system to maintain enough oxygen-rich blood in the brain and vital organs. An animal in shock needs professional veterinary treatment as soon as possible. Call your vet immediately because shock is a physiological condition which will worsen until the goat lapses into a coma and dies if original cause and the shock are not treated quickly.

Clinical signs:

- cold extremities;
- goat is down and distressed;
- pulse is rapid and weak;
- pale dry mucus membranes;
- reduced or no urination;
- lack of rumen sounds;
- dilated pupils.

Treatment depends upon the cause of the shock. The three most common causes of shock in animals are hypovolemic shock (caused by loss of fluids), distributive shock (caused by an abnormal flow of fluid into the tissues, often due to septic shock caused by infection) and anaphylactic shock (caused by insect bites, vaccination, medications or antitoxins).

Hypovolemic shock in goats is usually due to blood loss or loss of fluid from diarrhoea. If the shock is due to haemorrhage, the bleeding must be stopped and the blood volume increased – a job for the vet, who will treat the cause of the bleeding and give intravenous fluids to increase blood volume and antibiotics to prevent infection. Whatever the cause, you will need the vet to treat it. While you are waiting for the vet, deal with obvious problems. Stop any bleeding, using a pressure pad bandaged over a wound then, if it is safe, move the animal to shelter. When you have moved the goat to a sheltered place cover it with feedbags or old blankets to keep it warm. Do not offer fluids or food to an injured animal in shock. The animal may need an anaesthetic: if it vomits while unconscious and inhales the vomitus into its lungs, pneumonia may result.

Septic shock due to bacterial infections will kill rapidly so you must get veterinary help as soon as possible.

The clinical signs of septic shock are chills and shaking, fever, rapid pulse, obvious illness and collapse.

If the goat is reacting to a drug, injection or insect sting it may be suffering anaphylactic shock, also known as anaphylaxis. This occurs when the body has an allergic reaction to any substance that it recognises as a threat. The tissues release histamine and other substances, which causes a number of symptoms. The histamine makes the blood vessels dilate, which lowers blood pressure and allows fluid to leak from the blood vessels into the tissues, thus lowering blood volume. Fluid leaking into alveoli (air sacs) in the lungs causes pulmonary

oedema; if it leaks into throat tissues they will swell and obstruct the airway, making it almost or completely impossible for the goat to breathe.

Do not force fluids because the goat cannot swallow if its throat is swollen, and it may choke or inhale the fluid into its lungs. If the shock is due to vaccination reaction (common in Saanen goats) or insect stings, the vet gives an injection of epinephrine – if the animal hasn't died first!

Snakebite

Often a goat is found dead for no obvious reason. Producers sometimes believe that their husbandry practices are at fault, but if death occurs during warm weather it may be due to snakebite. Typically the goat will have puncture marks at the bite site, which is usually on the face or neck because the goat disturbed the snake when grazing. There may be non-clotting blood around the mouth and nostrils. This is typical of tiger snake, eastern brown snake, taipan, copperhead, mulga snake and death adder bites. If the goat is alive it may have dilated pupils, drooping eyelids, a lower lip hanging slackly and it may be drooling. The goat often appears to be disoriented and stands in one position for a time before collapsing.

Don't wash the bite. The vet can test venom left around the bite site to determine the type of snake that inflicted it, but antivenene for snakebite is expensive and is only justified for valuable animals.

Udder engorgement

This usually happens in the first few days after kidding, often on only one side of the udder but sometimes on both. One-sided engorgement is usually caused by the kids sucking on only one side of the udder. For some reason, kids often take a liking to one side of the udder for the first day – within 24 hours the neglected teat is so swollen with colostrum that it is too big for kids to suck on even if they want to. Another reason the kids may be nursing on one side of the udder is that, despite several attempts to suck on a teat, they cannot obtain any milk because the teat is blocked by the protective keratin plug. The kids eventually give up and feed only from the teat where the colostrum or milk flows readily.

The doe is not usually very helpful because the blocked teat is tender and when the kids attempt to feed from it she moves away and allows them to feed only from the less-tender teat, which compounds the problem.

If the udder is engorged on both sides there are several other things to check.

Are the kids getting enough colostrum or milk when feeding? This is easy to ascertain because if they are they will be sucking well, have a nice round tummy and obviously be fit and vigorous.

If the kids are fine the problem could be overproduction of milk. The congestion must be relieved by milking out enough milk to relieve the tension so the udder begins to feel softer (if the liquid milked out is colostrum, it should be saved and frozen for later use). Do not milk out more than is necessary to relieve the tension, or you will only encourage the production of more milk. The problem of milk overproduction occurs more often in dairy goats or South African Boer goats and is also found in first-cross South African Boer/Saanens due to hybrid vigour: in the last, the problem should rectify itself in the next generation.

The teat or teats should be examined to make sure that they are not blocked. If they are, the udder and teats should be washed with clean warm water and the plug of material gently expressed. Wear gloves so that you do not introduce bacteria into the udder and possibly cause mastitis. An old-fashioned human breastpump is very useful for removing the plug from the teat. In the case of blocked teats, kids may be hollow-sided and possibly hunched up and look miserable but once the blockage is removed and the kids have had a few feeds they will be fine.

Maiden does in their first kidding sometimes have very swollen and sore teats. These are painful and sometimes the doe cannot bear anything, including her kids, to touch them. In this case, you will have to be cruel to be kind. The doe will need to be restrained in a headbail for the first few feeds to allow the kids to nurse without her moving away. After the first few feeds the pain is gone and she usually allows the kids to nurse freely. If not, you will have to continue to hold her several times a day to allow the kids to nurse, or they will need to be fed artificially or fostered onto another doe. As mentioned in Chapter 5, we allow this only at the first kidding: a repeat performance sees the doe culled because mothering instinct is a heritable trait.

Other problems can lie with the kid itself because it may have a genetic defect, such as a cleft palate, that does not permit it to nurse properly. This defect will not permit the kid to form a proper vacuum because there is a gap in the palate (roof of the mouth) that did not close before birth. When the kid attempts to suck, milk or colostrum flows from its nostrils. Such a kid such should be culled.

In other instances the kid may be too weak or small to use all the available milk or, if its littermates have been lost to predators, there will be a temporary oversupply of milk. The milk production will adjust itself to the decreased demand within a few days. Meanwhile it may be necessary to relieve the pressure in the udder by milking off some of the surplus milk. Do not strip the udder, because the aim is to decrease milk production to the level of demand. Before you begin to milk out some of the excess milk it is useful to apply cloths dipped in warm water to the udder for a few minutes, to help the letdown of milk. It also helps to relieve the pain of swollen and sore teats.

The cause of udder engorgement should be found and dealt with as soon as possible because if it is left untreated the doe will develop mastitis.

White muscle disease

This condition, also known as nutritional myopathy, is usually caused by a severe dietary deficiency of selenium due to very low soil levels. White muscle disease occurs mainly during spring. Kids and lambs in low-selenium areas do not grow well after weaning, begin to weaken and finally collapse and die. A post-mortem reveals white or light-tan streaks in the heart and the leg and back muscles. These are areas of dead cells and are pale because of lack of blood flow.

Selenium is essential for such fundamental biological processes as reproduction and growth and a deficiency of it has been found to cause stillbirth and embryonic resorption in sheep (Oldfield 1999). Because of its importance for reproduction and growth, it is necessary to supplement goats in areas where there is a deficiency of selenium in the soil and hence in the pasture.

Clinical signs of white muscle disease are kids that are stillborn or die within a few days (although this can be symptomatic of other conditions). Delayed white muscle disease can occur one to four months after birth. Signs of delayed white muscle disease are unsteady gait, hunched body position, weakness, lack of thriving, collapse and death.

Treatment involves selenium supplementation, but this should only be used if you have a known soil deficiency because selenium is highly toxic if stock are overdosed with it. In the US the 'blind staggers' (or 'alkali disease') was thought to be the result of stock drinking from alkaline ponds, but was in fact caused by selenium poisoning: in one area alone more than 15 000 sheep died in one year from selenium poisoning (Wyoming State Board of Commissioners 1908).

The animals were poisoned by grazing on plants that accumulate selenium. These are known as indicator plants because they grow only in highly seleniferous soil. Australia has several known selenium indicator plants: *Pogonolobus retuculatus* in the Northern Territory and north Queensland, *Morinda reticulata* in Queensland on Cape York Peninsula and *Neptunia amplexicaulus* around Richmond in north Queensland. Selenium poisoning from plants is rare because indicator plants have such a limited distribution. However, horses have been poisoned by *Morinda reticulata* and by *Neptunia amplexicaulis*.

Several products address selenium deficiencies in livestock. Some come in the form of injections that must be given under veterinary direction and selenium bullets are also available. When given (with a special applicator), these lodge in the rumen and release selenium slowly over an extended period. It is also incorporated into some anthelmintic (worm) drenches and many mineral licks and vitamin supplements contain selenium.

Some highland areas of Victoria with high rainfall and acid soils have a known deficiency of selenium and in these and similar areas it is possible to topdress pasture with a selenium and superphosphate mixture. There are fertilisers registered for this in some states and the local rural supplier will be able to say which are available in your area. First, however, a soil test or pasture test must be done to establish the selenium level and decide whether topdressing is required. Talk to the local Department of Agriculture extension officer if testing reveals a deficit of selenium.

White muscle disease can also be induced by the stress of mustering, poor vitamin E nutrition or a rise in unsaturated fatty acids in spring pasture.

Wounds

The three most common types of wounds suffered by goats are bites from dogs or other animals, puncture wounds from staking themselves on branches, old fence posts or any sharp pointed objects, and cuts from sheets of iron, broken bottles and so on.

Bites from dingoes, feral dogs (domestic-type wild dogs) and domestic dogs are a serious problem in Australia and cause major losses for goat and sheep producers, due to dog attacks on herds and flocks. Some attacks could be prevented if owners kept their dogs under control at all times, especially at night. We have suffered the loss of literally hundreds of goats over the years, due to dingo and dog attacks on our herd, both at night and during the day.

Dog bites cause serious injury to stock and what may look like a simple puncture mark in the skin can actually be a major injury. If dingoes bite a running animal a tooth (normally

the canine) will puncture the goat's skin – the skin will stretch but the muscle and tissues underneath it won't, and they tear. This causes severe injury, extensive bruising and sometimes death.

An illustration is a dingo attack that occurred on our property some years ago when four young dingoes attacked our herd in broad daylight. Several goats had massive and obvious injuries such as disembowelment and were promptly destroyed, but one seemed to have only two puncture wounds on the abdomen and two on one leg. She died within five minutes. We decided that we should investigate why she died so quickly, and did a post-mortem. When the hide was removed, we were amazed to see that the leg with only two puncture wounds was bruised black from hip to knee and the thigh muscle was shredded. Upon opening the abdomen over the two puncture wounds, we found that the liver and intestines were torn in several places. The abdominal wounds had caused severe internal haemorrhage, which killed the goat.

When wounds from dog bites are more than superficial a vet should be called, especially if bites are on the goat's flanks, stomach or udder.

If you are certain that the wounds are only superficial, they need only to be cleansed thoroughly with hydrogen peroxide solution or a disinfectant such as buffered iodine and dressed with an antiseptic cream.

The mouths of dingoes and wild dogs are alive with bacteria because they eat carrion such as the carcasses of sheep, cattle, kangaroos, goats etc. and are not fussy about carcass condition. Because of this, a bite from any dingo or dog is serious and must treated as soon as possible if major infection is to be avoided.

If the goat becomes feverish or the wound begins to suppurate your vet will prescribe further treatment, usually antibiotics. You should be alert to the possibility of shock after dog attack, as this is quite common due to trauma and blood loss.

Treatment

When treating bite wounds, make a solution of one part 6% hydrogen peroxide to four parts sterile (cool boiled) water then, using a 25 mL syringe, clean out the puncture wound. The hydrogen peroxide fizzes out of the wound when it reacts with blood and serum and will clean out most of the debris and bacteria from the dog's bite. When you are certain that the wound is clean, introduce some antiseptic cream to help prevent infection. If you do not have hydrogen peroxide, buffered iodine can be used instead. At the first sign of infection, call your vet.

Puncture (penetrating) wounds on the extremities or only shallow should not be a problem as long as bleeding is not excessive and tetanus vaccinations are up to date. If bleeding is not excessive or the wound is obviously not serious it can be cleansed with hydrogen peroxide solution or a saline solution (one tablespoon of salt in 2 L of warm water). After bathing the wound treat it with buffered iodine and bandage it if necessary. If infection, shock or fever develop the vet must be consulted. The vet should be consulted for wounds on the body if they appear to penetrate more than skin-deep. Abdominal skin is very thin and wounds there may penetrate into the abdominal cavity and cause peritonitis, killing the goat.

Cuts can be minor or quite serious. Minor cuts need only be sprayed with an antiseptic such as buffered iodine and left to heal by themselves. More serious cuts and abrasions need to be assessed on an individual basis.

If the cut or abrasion is deep it will need to be bandaged after being cleaned up. If the wound is on a limb don't skimp on the bandage – bandage from one joint to the next and fix in place with a generous piece of Elastoplast® to ensure that the bandage does not fall off. Make sure the bandage is not tight enough to cut off circulation in the limb. If the wound is bleeding profusely and the bleeding cannot be easily stopped, apply a pressure pad, bandaged to stay in place if necessary and call the vet as soon as possible. Very deep wounds, especially on the limbs, may cut tendons and need veterinary treatment.

Do not apply a tourniquet to a bleeding limb. Unless the tourniquet is removed within half an hour there will be so much damage to nerves, circulation and tissue below the tourniquet that the limb may have to be amputated.

If the edges of the wound are gaping it will need suturing (stitching); unless you have the experience and equipment you will need to call your vet. Experience will teach you when you need to call the vet to deal with cuts and abrasions and when you can safely treat them yourself.

Zoonotic diseases

A zoonotic disease is a disease that may be transmitted to humans from another species. They include Q fever, brucellosis, rabies, plague, ringworm and toxoplasmosis. Fortunately, not all of these are present in Australia but some of them, such as Q fever, cause thousands of lost work hours and some deaths annually.

Brucellosis is a zoonotic disease caused by *Brucella ovis* and mainly affects sheep, in which it causes abortion. The disease is notifiable. The incubation period ranges from 50 to 250 days. It rarely affects goats but can cause debilitating illness in humans.

Q fever is caused by the bacterium *Coxiella burnetii* and was named by John Derrick, who described the outbreak of a febrile illness in abattoir workers in 1935. Sir MacFarlane Burnett and R. Freeman isolated the microorganism (now called *Coxiella burnetii*) from guinea pigs that had been injected with the blood of a patient (Ferguson 1997). The organism is widespread in Australia and found in many species including cattle, sheep, goats, dogs, cats, kangaroos, bandicoots and ticks. Animals are asymptomatic carriers (show no symptoms). Humans are not so lucky and, if they contract the disease, can become extremely ill and may die. Approximately 200 people each year require hospitalisation and an average of three die. Not only abattoir workers contract Q fever; 50% of cases occur outside the meat industry.

Q fever is often contracted from inhalation of contaminated dust and aerosols or by contact with anything contaminated with faeces or milk such as wool, hides, hair or pregnancy-related tissues. The last are the most potent source of infection. During kidding season producers are frequently in contact with amniotic fluid, blood and placental tissue, which can contain up to 1 billion *Coxiella burnetii* organisms. Infection can be caused by fewer than ten organisms. The risk of contracting a zoonotic disease is one of the reasons that we always suggest wearing gloves and eye protection when handling or treating injured or sick livestock. There is an incubation period in humans of one to four weeks, during which there may be no symptoms. Clinical signs in humans are headache, fever, muscle pain and, in severe cases, pneumonia or hepatitis.

Most patients recover without incident and are then immune. A possible after-effect is chronic fatigue syndrome lasting many weeks or months and a few unfortunates may

relapse years later with chronic endocarditis or granulomatis hepatitis. Since 2002, there has been a subsidised vaccination scheme for workers in the cattle, sheep, alpaca and goat industries to prevent Q fever.

Hydatid disease (dog tapeworm) is a serious public health risk in sheep areas and is sometimes fatal in humans. It is discussed further in Chapter 10.

Toxoplasmosis occurs in mammals and birds worldwide. Humans can contract it by eating undercooked meat but it can also be contracted from contact with infected soil, such as that contaminated with cat faeces. Toxoplasmosis can have serious consequences in pregnant women and their babies.

Because of the risk of contracting a zoonotic disease, pregnant women should not assist does to give birth. If they cannot avoid assisting, they should take every possible precaution to avoid direct contact with the placenta and amniotic fluid etc. by wearing eye protection, protective clothing and gloves.

10

Parasites

All animals are affected by some type of parasite from time to time. Some do not greatly affect the health of the animal but can cause economic loss to the producer. Two such parasites, the biting and the sucking lice, attach their eggs to the hairshafts of the fleece. The egg casings cause uneven uptake of dye during processing and their presence means that the producer's clip will be downgraded, involving a substantial loss of income.

Other parasites, such as intestinal nematodes, tapeworms or scrub ticks, can cause anything from ill thrift to slow growth or even death. This chapter discusses the most common internal and external parasites of goats, and some ways of dealing with them.

Intestinal parasites

Intestinal worms, coccidia and liver fluke cause enormous economic losses to the sheep, cattle and goat industries worldwide. Australia is lucky that its isolation from other countries has protected it from such nasties as the meningeal worm (*Parelaphostrongylus tenus*) found in North America but unfortunately there are some species that cause significant annual losses to Australia's livestock industry.

Good husbandry with close attention to drenching and paddock rotation can help to control internal parasites. Cross-grazing with cattle is useful in controlling worm infestation in goats. It is also useful to have regular faecal egg counts done to monitor the parasite status of your herd. You can learn how to do faecal egg counts yourself and, with a little practice, how to recognise the Strongyle family of worms, coccidia and tapeworms. This will allow you to decide which drench to use and when to use it. If you don't have time to learn how to do the faecal egg count yourself, the government laboratory can do it for you. The cost of testing is worthwhile even if it only saves one or two goats, as the charge is usually very reasonable. Note: even if you do faecal egg counts yourself you will still need the

laboratory to check the fluke status of your flock, because fluke eggs do not float on the solution used.

When drenching goats they should be drafted into mobs of roughly the same sizes and weights. Each mob should be drenched with the dose appropriate for the heaviest goat in the mob. If goats fall within a weight category then drench to the next 10 kg, i.e. if the goat weighs 11 kg drench it for 20 kg, if it weighs 25 kg drench it at the 30 kg dose.

Never underdose as that will build drench resistance. The process of selection for resistance is quite simple: when a goat is underdosed with a drench only the most susceptible worms are killed. The rest are only temporarily slowed down and will begin laying again within a few days. You may mistakenly believe that the drench is at fault, whereas in reality resistance happens when goats are being underdosed. If underdosing continues for a few seasons, only the worms that are tolerant to the drench will survive and you must deal with drench resistance.

Resistance to one type of drench in a group will mean that the worms are resistant to all drenches within the group. This has happened on a number of properties with some macrocyclic lactones such as ivermectin and moxidectin, and fenbendazole and others of the benzimidazole group. Drench resistance is usually permanent. Even if you use a different group of drenches for a number of years, the worms retain their resistance to the original group and its effectiveness is not restored.

There is evidence that goats metabolise the benzimidazole group of drenches differently from sheep and should be drenched at double the recommended sheep dose for sheep (Luginbuhl 1998). Do not use albendazole or oxfendazole on pregnant does as it has been known to cause adverse effects in pregnant sheep.

Levamisole and ivermectin should be used at only 1.5 times the sheep dose. The injectable ivermectin made for cattle is often used by goat producers but experimentally the oral ivermectin is found to be more effective, especially in goats (Luginbuhl 1998). The withholding period is also shorter when the oral product is used. Note: ivermectin was not registered in Australia for use in goats at the time of writing, but may be in the near future.

Table 10.1 shows drenches registered in some states and territories for use in goats. They may not be registered for goats in all states, so check with your primary industry or agriculture departments before using them. Note that the names given are the active ingredient, not the brand name of the drench. The export slaughter interval is the recommended interval between treatment of an animal with a veterinary chemical and the slaughter of that animal for export into a market whose statutory requirements for residues in meat are different from those of the Australian domestic market.

Drench resistance has become a major problem in Australia so a program for the control of worms in stock and pastures has been developed, in which drenching is only part of a total management strategy. The management plan was marketed in 1984 by CSIRO, the Department of Agriculture (NSW) and the Pasture Protection Board (NSW). The first program, called Wormkill, was introduced to the Hunter and Northern Tablelands regions. It was so successful that other state governments soon adopted similar programs – Drenchplan (southern NSW), Wormplan (Vic.), Wormcheck (SA), Wormbuster (Qld), CRACK (WA) and Weaner watch/Drenchplan (Tas.) (Martin 2003).

Table 10.1 Drenches registered for use in goats

Chemical	Dose rate	Withholding period (days)		Export slaughter interval
		Meat	Milk	
Clear (broad-spectrum)				
Morantel	1 mL/3 kg	7	Not for lactating animals	–
Narrow-spectrum				
Triclabendazole	1 mL/5 kg	28	Not for lactating animals	63 days
White (broad-spectrum)				
Albendazole	1 mL/4–5 kg	10	Not for lactating animals	–
Fenbendazole	1 mL/5 kg	14	24 hours	Not established
Oxfendazole	1 mL/10 kg	10	Not for lactating goats	Not established
Neguvon trichlorfon (organophosphate)[1]	5 mL/kg[2]	7 (min.)[3]	28 (min.)[3]	Unknown. Check with vet before use.[4]

[1] Off-label permit drench: permit no: PER6304. All states except Victoria because its 'control of use' legislation means that a permit is not required for off-label use in Victoria.
[2] Comes as a powder. Mix 12.5 g (6 measures) per 100 mL water. A 400 g container makes 3.2 L of drench, which is enough to dose 213 goats weighing 30 kg. Use where there is resistance to other drenches used for control of *Haemonchus* spp. (Barbers Pole worm).
[3] Australian Pesticides and Veterinary Medicines have established the following permitted maximum residue limits: meat and offal = 0.1 mg/kg. Do not overdose.
[4] Permit status under review at time of writing.

Trichostrongyles

The family of nematodes called Trichostrongyloidea causes enormous financial losses worldwide each year. Australia suffers major losses in production due to reduced growth rates, poor feed conversion (due to gut damage) and livestock losses. The Trichostrongyles are found in the abomasum or small intestine of goats depending upon the species or worm. Most of this family of worms are responsive to drenches listed in Table 10.1 that have been registered for use in goats.

Barbers Pole worm

This worm (*Haemonchus contortus*), which belongs to the Trichostrongyloidea family of nematodes, causes significant losses to goat and sheep producers throughout the world. In the US, laboratory studies (Rollins Animal Diagnostic Laboratory, Raleigh) have shown it to be the leading cause of goat death in the US and we believe that if studies were done in Australia similar results would be found.

The Barbers Pole worm thrives in warmth and moisture and is usually most active in summer when conditions favour their reproduction and survival. If a significant fall of rain is received in summer after a dry spell, there may be mass emergence of Barbers Pole worm. In these circumstances, a fat goat, which appeared to be healthy only a day or two before, may be found dead in the paddock without obvious cause. The goat ingested such a massive quantity of larvae that it died before they could begin laying eggs. The worms take 21 days from ingestion to maturity and egg-laying, and because a goat can die within 10 days of ingesting large quantities of Barbers Pole worms a faecal egg count usually doesn't show any eggs in the dung.

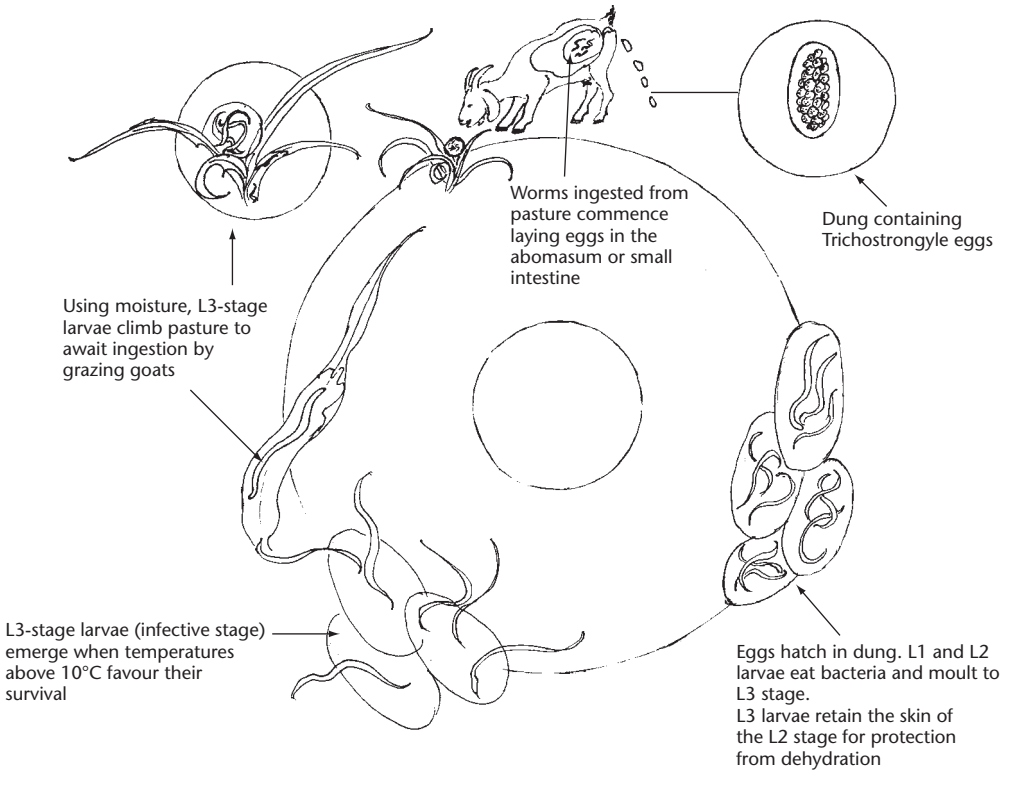

Figure 10.1 The life-cycle of trichostrongyles

There are several stages in the life-cycle of the Barbers Pole worm, most spent outside the body of the goat.

Adult Barbers Pole worms live in the abomasum. The female lives for about three months, during which time she will produce 5000–10 000 eggs per day! This large number of eggs helps the parasite survive drought conditions. Eggs in the dung hatch when temperatures are higher than 10°C. These first-stage larvae live on bacteria in the dung and moult to second and third stage. The L3 larvae, which retain the skin of second-stage larvae for protection, are called the infective-stage larvae. The first- and second-stage larvae (L1 and L2) are vulnerable to desiccation and death, so long dry periods such as drought can lessen contamination of paddocks but will not clear them: although the L3 stage will dry up during drought, when ingested it may rehydrate to lay eggs and complete its life-cycle. In ideal conditions, where the dung does not desiccate but retains its moisture (for example in shade or long grass) the eggs and larvae can survive for several months. Perhaps this is the only good thing to be said about drought: it lessens the number of worm eggs and larvae in the paddock.

The next stage is a waiting game for the L3 (infective larvae). L3 larvae migrate from the soil onto pasture and live in the moisture at the base of plants. They travel up grass stems when there is moisture present, for example they use the morning dew to climb stems and as it dries up during the day travel back down again. Some producers keep their goats confined in the yards until the dew dries off each morning. If there is plenty of good grazing

this could be a useful technique, but if pastures are a little scant it may not allow sufficient time for grazing. We feel that there are better techniques for controlling parasites in the herd.

Misty days or days of light rain also allow the worms to climb pasture stems to await ingestion by goats or sheep. Using this technique of travelling up and down the stems of the grass or other pasture, worms can survive for months.

The shorter the pasture, the more likely the goats are to become infested. If pasture is shorter than about 6 cm it is likely that goats will swallow larvae because the worms normally only climb up the first 5 cm of plants.

Once ingested, the blood-sucking larvae begin to feed on the blood in the abomasal wall and complete their life-cycle by beginning to lay eggs in 21 days after ingestion. Some larvae, however, undergo a process called hypobiosis (seasonal arrested development). These worms lie dormant in the abomasum lining and do not mature until several months later. This ability allows the worms to overwinter in a safe environment and to emerge and begin laying eggs when conditions are more favourable to survival.

Hypobiosis in Barbers Pole worms is the reason for a surge of infection during spring when the weather begins to warm up. Because the worms can arrest their development and emerge en masse from the abomasum lining we often see severe parasitism within 7–10 days of drenching, sometimes confused with drench resistance.

Clinical signs:

- bottle-jaw – a swelling under the chin is most often noticed first. This swelling is often not noticeable in the morning when the goats go out to graze, but is obvious in the evening when they have had their heads low all day for grazing;
- anaemia – pale conjunctiva (check inside lower eyelid), pale mucosa (check gums and lips). Skin around the anus and vulva may be quite pale in light-skinned goats;
- occasionally there may be diarrhoea;
- coat is dull and rough;
- in severe infestations, goats will lose weight, become very weak and die.

Barbers Pole worm infestation should be treated as soon as possible because the longer it goes untreated the more damage the worms will do to the gut. The worm makes a small wound on the lining of the abomasum and each wound creates a tiny scar. More worms equals more scars, until there is so much scar tissue that it interferes with absorption of nutrients and, though the goat eats well, it shows ill-thrift and never does as well as its herdmates. If infestation is not controlled in young growing goats, they will grow much more slowly than otherwise and are often stunted, never reaching their full growth potential.

Treatment involves drenching with a benzimidazole (white drench). Closantel, a salicylanilide, is also effective but some resistance has been found due to underdosing by producers who underestimate the true weight of their goats. Due to (unconfirmed) reports of abortion in does, closantel should not be used in pregnant does. Albendazole and oxfendazole have also been associated with problems in pregnant sheep and should be avoided in pregnant animals. Although ivermectin should be safe, it is not presently registered for use in goats so ask your vet to recommend a suitable drench for pregnant

does. In any case, does should not be drenched in the first six weeks or the final six weeks of pregnancy (see Chapter 4).

Black scour worm

Trichostrongylus axie and *Trichostrongylus colubriformisis*, commonly known as black scour worm, often cause severe, very dark or black-coloured diarrhoea. This worm prefers cool damp conditions and is more common in the cooler months. The adult worm produces around 200 eggs per day. Losses caused by black scour worm are usually smaller than those due to Barbers Pole worm, but do occur.

Clinical signs:

- very dark to black-coloured diarrhoea;
- loss of appetite;
- weight loss in adults and slow growth in kids;
- coat is dull and rough;
- weakness in severe infestations;
- if left untreated, death.

Brown stomach worm

Ostertagia spp. prefers cooler climates but is found even in subtropical regions in cooler tableland areas, such as the Stanthorpe area in Queensland. Like Barbers Pole worm, it can undergo hypobiosis (seasonal arrested development), lying dormant in the wall of the abomasum, but unlike *Haemonchus contortus* that emerges in the warmer months the brown stomach worm emerges in autumn when the weather begins to cool.

Clinical signs are scouring and significant weight loss. The benzimidazole or white drench group or macrocyclic lactones, such as ivermectin, moxidectin or abamectin are usually effective against this parasite.

Hookworm

Bunostomum trigonocephalum is found in tropical areas. In ruminants such as goats it is either ingested or penetrates just above the hoof, from where it travels to the lungs. It burrows from the lungs into the throat and is swallowed. When the hookworm reaches the intestine, it penetrates the wall with a lancet and the muscular pharynx begins to pump blood. Even when the worm detaches itself from the intestine wall the wound continues to bleed, leading to tarry stools in affected animals.

Clinical signs:

- weight loss;
- tarry stools;
- anaemia;
- weakness;
- if untreated, it may cause oedema and finally death.

Drench the goats. We recommend a course of B12 and iron injections to help them recover more quickly, because animals that have had a significant infestation of hookworm are usually very anaemic.

Nodule worm

Osophagostomum spp. causes nodules around the anus and rectum. The nodules on the wall of the rectum are dead calcified larvae. Nodule worm infection is less common than during last century.

Clinical signs are dark-green scour that contains mucus and flecks of blood (Lyndal-Murphy & McLeish 1997). Note: symptoms may be mistaken for enterotoxaemia or the results of lush feed.

Treatment involves drenching and rotating to clean a paddock.

Threadworm

Strongyloides papillosus, also known as intestinal threadworm, infects goats by penetrating the skin of the mouth, and kids via their mother's milk. As in sheep, infection in kids occurs between the first and the third weeks of lactation. There may be enough larvae stored in the doe's udder to infect several generations of kids!

Threadworm eggs may be detected in faeces 8–10 days after infection. They are a little over half the size of the eggs of *Haemonchus contortus* and are laid embrionated (with a living larva inside); the larva can be seen moving inside the egg and in warm weather will hatch within a few hours.

Clinical signs are loss of condition, diarrhoea and a poor coat.

Treatment is a drench with a benzimidazole (white drench), which usually takes care of the problem. After the goats have emptied themselves out in a few hours, move them to a clean paddock.

Prevention: threadworm often occurs where there is overstocking, overcrowding or where goats are confined to small earth yards and fed on the ground.

Tapeworm

Two types of tapeworm commonly infect goats and sheep. The most common and least important is the *Moniezia* spp. Infection with this group is very common in kids. The second type of tapeworm is the hydatid tapeworm (dog tapeworm) (*Echinococcus granulosis*). In humans, who are an intermediate host, the consequences of infection can be grave with an average hospital stay of 23 days. Simple infection with the *Moniezia* spp. in kids usually slows their growth because the worm competes for nutrients. Kids with this infection often have a potbelly and grow more slowly than expected for their breed and age. We have noted that they can also be anaemic.

The life-cycle of the *Moniezia* spp. is simpler than that of the hydatids tapeworm or the liver fluke but is still what is termed an indirect life-cycle, as it requires an intermediate host. In the case of *Moniezia* spp., this is a species of pasture mite.

- The final host, usually a kid or lamb, passes the mature proglottid segments that contain the tapeworm eggs with its faeces.
- The walls of the proglottid segments rupture to release eggs.
- Either the proglottid segments or the eggs are eaten by the mites.
- The intermediate hosts, mites containing hatched tapeworm eggs, are ingested by grazing animals: goats are particularly vulnerable to infection because they often graze the pasture down to soil level.
- The mite is digested, releasing the tapeworm larvae which then attach to the wall of the small intestine.

Because the time from infection to release of the egg-containing proglottid segments is approximately six weeks, drenching kids younger than six weeks of age is unnecessary and poor economic management, when the cost of drench is considered.

Drenching for tapeworm can be undertaken if necessary from six weeks of age using one of the benzimidazole drenches. The four drenches used most often, that also appear to be quite effective, are albendazole, oxfendazole, mebendazole and fenbendazole. The only drench approved for use in dairy goats producing milk for human consumption is fenbendazole, which has a 24-hour withholding period before milk can be used after drenching. There have been isolated reports of drench resistance to some or all of these products on individual properties.

Treatment of common *Moniezia* spp. tapeworm infection is with a white drench: use 6 mL if kids are under 10 kg and 9 mL if they are 10–15 kg. Albendazole is very effective and the kids often pass the dead worm in one or more pieces next day. The length of these worms can be impressive and it isn't unusual, after drenching, to see kids pass worms more than a metre long (Lyndal-Murphy & McLeish 1997). Occasionally the worm will block the intestine; often, the kid dies. We drench all kids at six weeks to kill any tapeworm so that they don't have to compete with worms for food.

Clinical signs are:

- ill-thrift;
- potbelly;
- slow growth;
- sometimes, anaemia (Morgan 2003).

If you suspect that kids are carrying a tapeworm drench as soon as possible, because the longer that it is left in the kid the larger it will grow. The bigger the tapeworm, the more likely it is to block the gut and kill the kid. From time to time, a kid will die after drenching for tapeworm from one of two causes: the dead tapeworms has caused an intestinal blockage or the dead and decomposing worms in the gut produce ammonia gas, which kills the kid.

To avoid these problems, drench as soon as you confirm by faecal egg count that a kid has tapeworm. The eggs are oddly shaped and are roughly triangular to quadrangular in shape and contain an embryo. Once seen under the microscope they will not be forgotten, as they are quite distinctive in form (see Figure 10.2) (Small 1995; Baxendell 1988).

Hydatids tapeworm

Hydatids disease is a notifiable zoonotic disease. The hydatids tapeworm (*Echinococcus granulosus*) itself is less impressive in appearance than the common *Moniezia* spp., being 6 mm or less in length fully-grown, but what it lacks in size it makes up for in the economic losses it causes the livestock industry and in its effects on the health of animals and humans. It has been estimated that up to 80% of old ewes from the tablelands of New South Wales may be infected with this tapeworm.

The life-cycle of the hydatid tapeworm comprises a number of stages.

- The definitive (primary) host (a dog, dingo or fox) eats food (in domestic dogs, this is often raw offal etc.) contaminated with protoscoleces, commonly known as hydatid sand.

- The protoscoleces (daughter cysts) attach themselves to the intestine wall, where they develop into a tapeworm that then begins to lay eggs.
- In approximately six weeks, when the tapeworm reaches maturity and has three or four segments it sheds the last segment, that contains as many as 1000 eggs. The dog will pass these. It will shed a new segment containing eggs every 14 days.
- These segments rupture to release eggs that are then transported by wind and water to new locations. They can remain viable for months, as they are quite resistant to weathering, including cool weather.
- The eggs are swallowed by the intermediate host. This can be any warm-blooded animal but is usually a sheep; goats can sometimes be affected. In the case of humans, infection occurs by hand-to-mouth transfer and many cases of infection are acquired by children when playing with farm dogs. Children play with dogs that have the eggs on their fur, picked up when rolling in dirt contaminated with dog faeces that contain eggs. Children eat or put their hands in their mouths without washing them and so the eggs are transferred to their mouths and swallowed. Adults can become infected when smoking or eating without washing their hands, after working in contaminated areas or handling dogs or animals that have eggs on their fur or fleece.
- The eggs hatch and larvae burrow from the intestine into the circulatory system and lodge in an organ, such as the liver, lungs or brain (usually the liver).
- Once a larva has reached an organ it forms a cyst which can grow as big as a golf ball: there have been cysts recorded that were 25+ cm in diameter. The cyst can remain in place growing slowly for many years without detection. Many cysts are found accidentally when a CT scan or X-ray is done for some other condition.
- If the cyst is ruptured, perhaps by a sharp blow to the chest or abdomen or accidentally during surgery, it will release the protoscoleces (hydatid sand/daughter cysts) inside. The sudden rupture and release of daughter cysts can have serious consequences, as it may cause fatal anaphylaxis (anaphylactic shock).
- The dog, dingo or fox swallows the protoscoleces (hydatid sand/daughter cysts) when eating offal from dead carcasses and the cycle begins again.

Prevention of hydatid disease in dogs has several elements.

- Never feed raw offal to dogs.
- In sheep country or areas where hydatid disease is known to exist, worm the dog every six weeks with praziquantel (Droncit®).
- Dispose of animal carcasses as soon as possible, by burning or burying.
- Teach children to wash their hands after handling dogs.
- Don't allow dogs access to vegetable gardens: fence them out.
- Treat infected dogs and destroy unwanted dogs.
- Keep dogs out of slaughteryards where they may have access to contaminated offal.

The serious health risk to humans from the hydatid tapeworm cannot be overemphasised and it has caused many deaths. A concentrated eradication campaign is required if there is to be any hope of controlling this threat to public health.

Several countries are taking steps to eradicate or control this disease: in Australia, Tasmania introduced a voluntary control program in 1962, made compulsory in 1966 due to public support. The number of cases in humans fell from 18 per year to four per year by

1983 and the prevalence of tapeworm in dogs fell from 12% to 0.04% (per dog) (Dept of Agriculture NSW). In Tasmania the domestic dog is the only host, which made control much easier than it is on the mainland where there are several other carriers. Eradication of this tapeworm in mainland Australia is not possible, and following the above methods and others suggested by your vet or Primary Industries Department are the only current means to help control the spread of hydatid tapeworm.

In humans, most cases occur in New South Wales followed by Western Australia, the Australian Capital Territory, Victoria and Queensland. Hydatid disease is not confined to Australia but is found throughout the world, wherever there are sheep and sheepdogs.

Treatment of hydatid disease in humans is usually surgery to remove cysts but sometimes, under a doctor's guidance, various anthelmintics (drugs to expel worms) such as mebendazole (Vermox®) or other products can be used successfully. Note: If you suspect you may have contracted hydatid disease **do not** self-medicate. Seek medical attention as soon as possible. Hydatids disease needs proper treatment from professional medical practitioners if serious long-term consequences are to be avoided.

Sources for this section were King (2000), Dept of Human Services (Vic.) (1997) and Queensland Health and the Department of Primary Industries & Fisheries (Qld) (2004).

Liver fluke

Fasciola hepatica causes liver fluke disease in sheep and cattle. It is a zoonotic disease and can have serious consequences if contracted by humans. Parasite damage to the liver of sheep and cattle also allows the bacterium *Clostridium novyi* to multiply in the liver, causing blacks disease that is usually fatal even when treated early. Production losses due to fluke costs producers up to $80 million per annum with a further $10 million spent on drenching. If liver fluke is detected in animals at the abattoir the livers are condemned; up to 5% of cattle livers are condemned at slaughter, some due to fluke infestation (Dept of Primary Industries and Fisheries, Qld).

The liver fluke is a flat leaf-shaped worm. Mature adults are 15–40 mm long and up to 12 mm wide. Young animals affected by fluke grow slowly. A heavy fluke burden can result in deterioration in wool quality, reduced meat and milk production and ill-thrift in young stock (Muirson 1994).

The liver fluke can develop to sexual maturity in almost any warm-blooded animal including humans, who can become infected by eating watercress from contaminated creeks. Flukes are found in areas with the snail *Lymnaea tomentosa* that is the intermediate host and the required damp environment for the fluke larvae. Liver fluke larvae favour marshy areas, irrigation channels, slow-flowing creeks and anywhere there is permanent water. Goats in Queensland have become infected while grazing along creek banks in warm coastal areas, but the snail host normally prefers cool and temperate high-rainfall areas.

The snail is indigenous to Australia and grows to 8–10 mm in size, is dark in colour and found in damp areas rather than in dams or water troughs. The recently introduced tropical snails *L. columella* and *L. viridis* have also become infected with the local strain of fluke. Disposal of aquarium weed into local waterways has allowed these exotic snails to thrive and opened up new areas of liver fluke infestation. The snails are present in the dairying regions of south-east Queensland but are capable of spreading into more northern warmer areas.

The life-cycle has several stages.

- The liver fluke lives in the bile ducts of the liver and, when mature, lays 20 000–50 000 eggs per day. A fluke can live up to 11 years and (in sheep) sheds eggs continuously, that pass out in the dung. Cattle develop natural resistance to the infestation by about 15 months of age and egg production declines.
- When temperatures are above 10°C and the dung is in a damp area, the eggs hatch too release miracidia**.** These invade the snail where they develop and multiply as sporocyst, rediae and cercariae. The tadpole-like cercariae leave the snails and swim to a suitable plant where they attach themselves and encyst to form the metacercariae that are the infectious stage of liver fluke. The cycle in the snail host takes two to three months.
- When the fluke is ingested by the host (sheep, cattle or human), the metacercariae release immature flukes that penetrate the intestinal wall into the abdominal cavity.
- The young flukes penetrate the liver capsule and migrate through the liver tissue for six or seven weeks before they enter the bile ducts where they become adult flukes. The flukes reach maturity and begin laying eggs 8–10 weeks after infection.

Identification of fluke infection is done by laboratory examination of faecal samples. An ordinary faecal egg count using the flotation method described later in this chapter will not pick up fluke eggs, because they do not float on saline solution as worm eggs and coccidial oocysts do (Dunn 2003).

Symptoms of acute fasciolosis, that usually occurs following a massive intake of metacercariae, are jaundice, abdominal pain and death from haemorrhage due to immature fluke burrowing through the liver. Subacute fasciolosis causes jaundice, ill-thrift and anaemia.

The animal dies from liver failure in 8–10 weeks due to haemorrhaging and liver damage caused by the burrowing fluke.

Chronic fasciolosis is the most common form of the disease and occurs when liver flukes in the bile ducts ingest blood. This causes chronic enlargement and inflammation of the bile ducts and anaemia. Its symptoms are jaundice, anaemia, bottle-jaw, poor appetite and unexplained deaths. Suspect fluke if stock have most of the above symptoms and are grazing in fluke-prone areas. Department of Primary Industries will advise on the fluke status of your area.

Treatment: there are various brands of drenches for treating fluke infection. Most contain either closantel or triclabendazole, which are usually effective although there have been reports of resistance in some areas. Before using any of the drenches recommended for fluke check that they are not contraindicated for your target market, because some countries have restrictions on what chemicals can be used in slaughter animals. Attention should be paid to withholding periods for both slaughter and export as it only takes one contaminated carcass in a container to have the container or even the whole shipment condemned.

To prevent liver fluke:

- fence off swampy areas to prevent stock access in regions where fluke has been identified;
- use rotational grazing;

- drench with a product that kills immature and adult flukes.

Two weeks after drenching, graze stock on the fluke-infested area and leave them there for six weeks, then move them back to fluke-free areas away from the snail habitats and graze for at least 10–12 weeks. Test again for fluke and, if the result is positive, drench. Repeat the cycle.

Sources for this section were Lyndal-Murphy and McLeish (1997), Boray (1999) and Muirson (1994).

Coccidia

Coccidiosis is caused by a small protozoan parasite (*Eimera* spp.) that has a fairly complex life-cycle and is species-specific. Producers need not fear that their goats will catch coccidia from ducks and poultry, for instance. However, species that affect sheep will also infect goats.

Though the parasite is small it can have an adverse economic impact on production, because of its effect on growth and weight gain in young goats. In severe infestations, it may cause a lifelong deficit in production because its damaging effect on the intestinal wall of affected animals interferes with the absorption of nutrients. Kids may be so stunted that they do not grow large enough to breed until their second season.

Goats become infected with coccidia when they eat feed or drink water contaminated with coccidial oocysts passed in the faeces of infected animals. Once in the gut the oocyst matures to form eight infective sporozoites; infected goats may shed thousands of sporulated oocysts each day. If a young kid swallows sporulated oocysts, the sporozoites they contain are released and immediately penetrate the intestinal wall (Smith 1992a; Baxendell 1988; Luginbuhl 1998; Proceedings 1990).

There are several stages in the life-cycle of the coccidial parasite and during these various stages within the intestine, before the protozoa matures and begins to produce oocysts, the damage caused to the intestinal wall is extensive. This damage may result in failure to thrive (ill-thrift) or, in acute cases where the kid has ingested large quantities of sporulated oocysts, it may die.

Clinical signs are slow growth, anaemia (not always; check for pale gums and inside the lower eyelids) and diarrhoea. If a young kid ingests a large quantity of the sporulated oocysts, it will become severely ill within three weeks. Symptoms of severe infestation are:

- being off feed;
- listless;
- abdominal pain (cannot settle, crying out in pain, lying down and getting up again as soon as it lies down);
- initial fever, dropping later to normal or subnormal;
- diarrhoea, at first pasty then turning watery (bloody diarrhoea is rare);
- dehydration due to diarrhoea;
- death.

Once symptoms of coccidia infection develop, damage to the gut has already occurred. Coccidial oocysts thrive in damp areas where infected dung has been deposited. Kids become infected by feeding from their dam's udder that has been contaminated with

infected dung, or from eating feed from damp dung-contaminated areas where the oocysts thrive.

Do not feed goats on the ground, especially in damp areas, and ensure that does have clean dung-free areas for kidding and sleeping, to minimise udder contamination. Ensure that water and feed troughs cannot be contaminated with dung and that kids cannot jump into them.

Does can be given feed that contains monensin – if you buy your feed in bulk, most nutritionists employed by feed supply companies will advise you about this. It is usual to start feeding concentrates that contain monensin several weeks before and after kidding, to minimise the oocysts shed by the does.

The use of toltrazuril (Baycox®), which was found to be highly effective against all intracellular stages of coccidia in US trials, has become widespread and though effective it is not yet approved for use in goats. Amprolium, which is registered for use in poultry, has been used extensively by many goat producers but repeated dosing can cause CCN (cerebrocortical necroses) because it may engender a vitamin B1 (thiamine) deficiency.

Other products are also available but if you suspect coccidial infection it is advisable to have a proper diagnosis done by your vet and or laboratory and follow their advice, because coccidiosis can resemble conditions such as dietary diarrhoea or infective diarrhoea.

When goats are drenched because of a suspected worm infection they often continue to scour because they have a concurrent coccidial infection that also needs to be treated. Your vet will set up a drenching program tailored to the specific needs of your herd.

Control measures: faecal egg counts and drenching

Faecal egg counts

To accurately ascertain the parasite burden in your herd, rather than routinely drench and possibly build drench resistance in parasites, the procedure known as a faecal egg count (FEC) is done on fresh samples of dung collected from a representative number of the herd, usually 10%. The result can be related to the group as a whole. The more animals sampled, the more accurate your average for the group. Below is a description of the FEC procedure as done on our property. We have found that learning how to do FECs ourselves has helped with herd management. If an FEC is carried out immediately an outbreak of intestinal parasites is suspected, it allows the level of parasite burden to be assessed and if necessary the herd to be drenched before too much damage has occurred.

The necessary equipment should cost under $600, even less, if you can purchase a used microscope. These are usually available for around $250; you also need a special four-chamber slide, called a universal 5 mL four-chamber slide, which costs around $85 and is available from scientific instrument suppliers. The easiest place to find a used microscope is in the classified ads of daily newspapers.

In an FEC we float the eggs from a faecal sample on a solution of saturated salt using the Universal 5 mL four-chamber slide (see Figure 10.2). The eggs float because of their specific gravity (hen eggs also float on saturated salt solution).

Producers often ask where to take their samples and which goats to sample. You must watch your herd as it goes out to graze each morning. You will see that there are goats

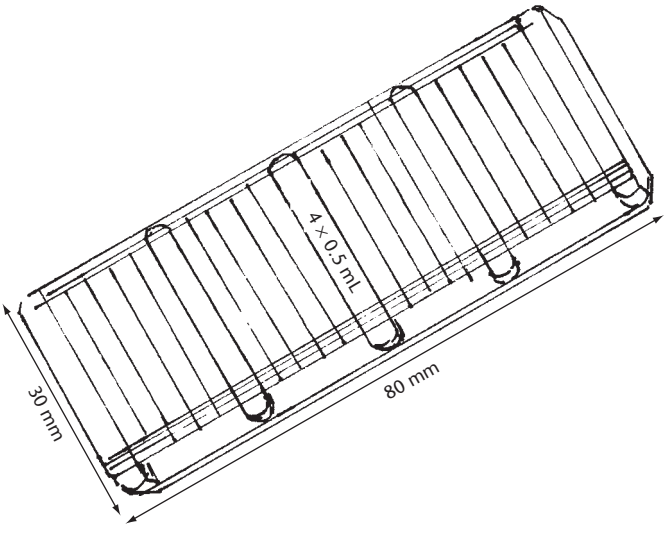

Figure 10.2 Universal 5 mL four-chamber slide

consistently in front, goats that trail at the rear of the herd and the rest somewhere in the middle. Representative faecal samples should be taken from these three areas of the herd:

- the lead group, which are more vigorous and healthy;
- the middle group;
- the ones that are always trailing behind.

The last group are the less vigorous and healthy goats and are therefore more likely to be carrying a higher parasite burden than the rest of the herd. They may have some other health or physical problem, but that would also make them more susceptible to worms due to a depressed immune system.

Equipment and materials

Materials and equipment needed are:

- 1 × student microscope with a mechanical stage (not a child's toy microscope) – look under Scientific Instrument Suppliers in the Yellow Pages;
- 1 × 8 eyepiece and a 1 × 4 objective – specify this when ordering your microscope;
- 1 × universal 5 mL four-chamber slide – look under Scientific Instrument Suppliers in the Yellow Pages;
- 1 masher – the plunger from a 25 mL disposable syringe is ideal;
- 2 × 100 mL containers with watertight lids for each faecal sample;
- 1 tea-strainer;
- 1 glass cover for the stage – this is to protect the microscope from salt damage as salt is highly corrosive (we make covers from clear plastic of the sort that is used on overhead projector sheets or from shirt or chocolate boxes);
- 1 pipette or eyedropper;
- 1 × 25 mL disposable syringe;
- 1 pipe-cleaner for cleaning inside the chambers of the slide after the test is completed;
- saturated salt solution.

The saturated salt solution should be made in advance, for example the day before, so that it has time to settle before use. We make 2 L at a time so that we always have some ready for an FEC. The solution keeps indefinitely.

To make the saturated salt solution:

- add 500 g of non-iodised table salt to 1 L of hot (not boiling) water while stirring. Keep adding salt until no more salt will dissolve in the water. Non-iodised salt is used because iodised salt makes a scum on the surface of solution, which makes it difficult to see the eggs;
- when the salt no longer wants to dissolve but falls to the bottom of the container, the solution is saturated;
- if the solution becomes cloudy, allow it to settle then carefully pour the clear part of the solution into another container and use that to do your FEC.

Sampling

Ideally, faecal samples should be collected directly from the goat's anus to eliminate the possibility of ground contamination, which can happen when samples are collected from the paddock or yards. To collect samples directly from the goat, put on a disposable glove and, with an assistant holding the goat steady for you, push your index finger into its rectum. You should be able to feel some faeces. Remove the required amount and place into a container (film canisters are ideal). Label the container and put it into a small six-can cooler that has a cooler brick to keep the samples cool.

The second method, which is not recommended, is to collect fresh faecal samples as they fall from the goat. This is the method that most producers, including us, use unless it is particularly important for the count to be completely accurate; if accuracy is vital, for example in an FEC reduction test, we use the correct method of collecting the sample directly from the goat.

Sample eight goats, obtaining six to eight pellets from each animal.

- Bottle samples separately and write the goat's tag number or identification on the bottles – mark the bottles not the lids!
- Use fresh faeces only.
- Faecal samples can be stored at 4–10°C in a sealed container to prevent dehydration.
- Counts should be performed the same day that samples were collected.
- To test for drench efficiency, take samples 7–10 days after drenching, no earlier.

Performing the test

Collect fresh faecal samples, assemble the necessary equipment and proceed as follows

1. Weigh 2 g of faeces from the sample and note the ID of the goat: write the result of the test against this when completed. Producers who do not have a scale accurate enough to weigh such small amounts of faeces may find the following helpful: 1 pellet from an adult goat (av.) = 0.5 g, therefore four average-sized pellets = 2 g; 8–10 small pellets from kids = 2 g; four to six medium pellets = 2 g; two to three large pellets = 2 g equivalent.
2. Place the sample into one of the 100 mL containers.

3 Draw up 25 mL of salt solution and use a little of this (and the masher) to thoroughly break the pellets up.
4 Add the rest of the syringeful of solution to the mixture then add a second 25 mL to that.
5 Screw on the lid of the container and shake well.
6 Strain into the second container and, using the masher, press the water in the manure through the mesh into the second container. This is so that you have all of the 50 mL of solution.
7 While stirring the solution, aspirate a full pipette from the middle of the solution. This is a little like patting your head and rubbing your tummy at the same time – it takes some practice.
8 Holding the slide horizontally in one hand and the pipette almost horizontally, fill one chamber of the slide. It is easier to fill the chamber evenly if you breathe into it so that a film of moisture forms on the interior.
9 Wind the microscope lens down so that it is just clear of the glass slide. The slide is very fragile and expensive, so be careful not to wind down onto the surface of the slide! Wait one or two minutes to allow any parasite eggs to float to the surface of the slide.
10 Looking through the eyepiece, wind the eyepiece up slowly until you are focusing on the air bubbles on the surface of the solution. The air bubbles are easy to identify because they are completely round, of assorted sizes, have thick black outlines and are void (empty) in the centre. Any eggs, with the exception of fluke eggs, will also be on the surface. Another way to know that you are focused on the surface is to focus on the lines that divide the chambers – once you focus clearly on these you are focused on the surface of the solution.
11 Count the visible eggs. There are four hollow chambers on the slide and each chamber is divided into five, by lines etched onto the surface of the chamber. To count the number of eggs in each chamber we scan down the first division in the chamber to the bottom, move across to the second division and scan up this to the top, then move across to the next division and scan down it. This procedure is repeated until we have counted the contents of the whole chamber. Note: the lines on the slide should border the circular area (field) you can see in the eyepiece. Only the eggs lying within the external double lines are counted.
12 Calculate the eggs per gram: multiply 2 g of weighed faeces × 50. For example, 20 eggs counted in the chamber × 50 = 1000 epg (eggs per gram).

Evaluating the results

The results of the FEC fall into three broad divisions of low, medium and high:

- low – <500 epg, subclinical parasitism with production deficit;
- medium – 500–2000 epg, drenching will prevent the onset of clinical signs, although these may already be evident in some animals;
- high – >2000 epg, drench immediately. This is a worm crisis. If you don't drench you may begin to sustain stock losses.

Faecal egg counts should be near zero 7–10 days after drenching. If they are not, then suspect drenching procedure, dosage or drench resistance.

Always clean your equipment as soon as you have finished, using warm water (not boiling), as salt is very corrosive. Fold the pipe-cleaner in half to clean the inside of the universal slide, to avoid scratches. Always do your tests in the same conditions, using the same methods for consistent results. Examine only fresh faeces. Keep samples in the refrigerator (not the freezer) until you are ready to post them to the laboratory or do your own FEC.

Counting coccidial oocysts

The need for treatment of coccidia infection will be determined by the oocyst count, the stress history of the goats and the clinical symptoms:

- low – oocysts in every field (× 40);
- medium – up to 20 oocysts in every field (× 40);
- high – >20 oocysts in every field (× 40).

The consistency of the faeces affects the FEC markedly. The FEC is based on the amount of moisture contained in normal well-formed droppings. More watery faeces will dilute the number of eggs.

- For fasting >12 hours, multiply epg × 0.5.
- For soft and unformed faeces, multiply epg × 2.
- For diarrhoeic faeces, multiply epg × 3.

When learning to do an FEC, count the same faecal sample at least four times until you are getting a consistent count. Then try to identify the type of eggs that you are seeing. You will not be able to differentiate between the different Strongyloides types, such as Barbers Pole worm or black scour worm, but with a little practice you should be able to distinguish the Strongyloides family of worm eggs.

You should also send samples collected at the same time, from the same goats, to your local laboratory for identification and counting. The results will tell you if your count was accurate (don't worry if it wasn't, as it takes practice) and the species of worm eggs.

Coccidial oocysts are only about half the size of Barbers Pole or black scour worm eggs. Under a microscope they look like transparent fat football shapes with a cluster of cells suspended in the middle; these are the sporozoites.

Moniezia proglottids are quite distinctive in appearance and are usually rectangular or roughly triangular.

Nematodirus (thin-necked intestinal worms) are usually not important, but are mentioned here because of their size. They are football-shaped, are up to 200 μ long and have a clear space around the contents, which consist of several large cells in the centre of the egg. There are usually very few in an FEC and they are about twice the size of most strongyle species eggs.

There are seasonal and regional variations in the worm species that will be active in your area. Many species are active according to temperature and rainfall and some, such as hookworm, are found only in the warm and damp tropical regions of Australia north of the

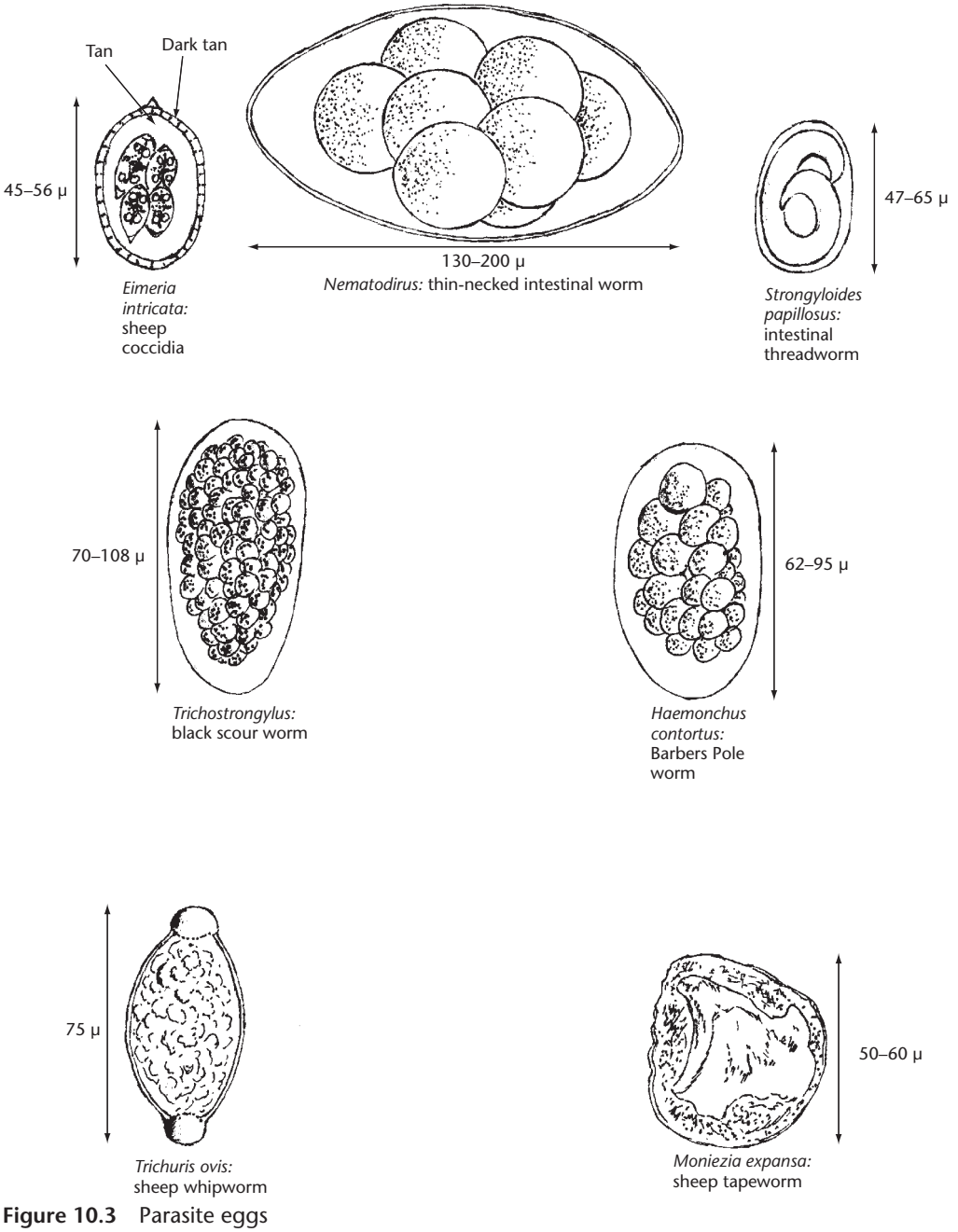

Figure 10.3 Parasite eggs

Tropic of Capricorn. In south-east Queensland, for instance, Barbers Pole worm is active in spring and summer when it is warm and damp and black scour worm is more active in winter when it is cool and damp. A typical FEC count done in summer in Queensland often shows an approximate ratio of 80% Barbers Pole worm to 20% black scour worm. The reverse occurs in winter, when the cooler conditions suit the black scour worm.

Drenching

Drenching is the term used for the oral administration of chemicals to which various species of worms are susceptible. It is used to control worm burdens in goats in conjunction with other management techniques such as paddock rotation and cross-grazing with other species, mainly cattle. It is important that the correct dose of drench be used and that goats are not drenched too frequently and neither overdosed nor underdosed, either of which may induce drench resistance in worms. Overdosing with some drenches can have serious consequences. Overdosing kids with drenches containing closantel, for example, can cause blindness.

When heavy rain occurs after a dry period, the number of parasites on pasture frequently rises dramatically as the parasites hatch from the softened dung and migrate up the grass stems, where they are ingested by grazing goats. If the temperature is above 10°C when rain falls it is time to do an FEC, because it is almost certain that the goats' worm burden will rise.

How to drench goats

You will need a drench gun (or disposable syringe if you have only a few goats to drench) and a drench backpack (this holds about 5 L). For a small mob, a container of drench will do. You will also need drench for the target species of worms. Usually this is a broad-spectrum drench such as albendazole, which covers most worms including tapeworm. Albendazole is not for use in goats producing milk for human consumption.

Studies done here and in the US have found that goats metabolise drench chemicals differently from sheep and that the most effective dose for goats is usually twice that recommended for sheep (Luginbhul 1998). Remember to be careful with products that contain closantel.

1. Yard the goats overnight to allow them to empty themselves out. Goats to be drenched should be off feed for a minimum of 12 hours. It is good idea to have a narrow race that takes six to eight goats at a time and has a sliding gate at each end. The race should be high enough that the goats cannot leap out (see Chapter 2).
2. Before you begin, draft the goats into mobs for size or age. Weigh the heaviest goat in each mob and drench all goats in that mob for that weight. This eliminates the chance of underdosing.
3. Check the dose delivered by the gun and adjust if necessary. We have twice made the mistake of not doing this, once when vaccinating kids and once when drenching goats. We had to do the whole lot again because the gun was delivering only half the dose: this was costly in both time and money.
4. Fill the race and, holding a goat by the left horn, introduce the drench gun from the right side at the rear of the mouth. Be careful not to knock any teeth out and ensure that the gun is on top of the tongue, not under it. Depress the trigger completely to make certain that the full dose is delivered. Do not pull the head higher than horizontal, because pulling the head too far back may allow the drench to be introduced into the windpipe and from there into the lungs, which can lead to pneumonia or even death.

5 Continue drenching until you have done every goat in the race, then release the freshly drenched goats into a holding area for four hours (with access to water in hot weather) before releasing them into a clean paddock.

Note: introducing the gun from the front of the mouth can invoke the sucking reflex which shunts the drench straight out before it has time to do its job of killing the parasites. If the goat spits out the drench, don't be afraid to give it another dose.

If you are drenching goats in the paddock, you can straddle the goat as you would a horse and, holding one horn with your left hand, drench the goat from the right-hand side. The goats obviously need to be obliging for you to do this. Straddling the goat allows you to control its sideways movement with your knees.

Other parasite control measures

Fencing the property into a number of small paddocks to allow frequent rotation of stock is a good management tool, but is costly in terms of material. Pasture spelling needs to be at least two months if the weather is very hot and dry, or six months in damp conditions. Some species of worms can survive more than a year under ideal conditions, so accepted spelling periods may not be correct in all conditions.

Cross-grazing with other species, either horses or cattle, has been found to be effective. Sheep are not used as alternatives because they harbour the same worm species as goats. The horses or cattle ingest the larvae or eggs from the pasture and the parasites die because they cannot live in those species.

Do not overstock. High stocking rates greatly increase pasture contamination.

Drench all new stock immediately upon arrival and keep them in a small holding paddock or yards for 10 days before releasing into the herd(see Chapter 3).

Try to have paddocks with more browsing, such as shrubs, woody weeds and trees, for goats as this will reduce their uptake of parasites.

Cultivate and re-sow pasture from time to time.

Drench when pasture contamination is at its lowest and before FECs begin to climb. It is important to act rather than react, because by the time goats show symptoms such as bottle-jaw or diarrhoea production losses have already occurred.

External parasites

Goats sometimes suffer from external parasites such as ticks, lice and mange mites.

Three important species of ticks can infest stock. Two of these can also be picked up by humans and their pets; some of these species also infest many native animals including kangaroos, bandicoots, snakes and lizards. The three species of ticks most likely to infest goats are cattle ticks (*Boophilus microplus*), paralysis ticks (*Ixodes holocyclus*) and bush ticks (*Haemaphysalis longicornis*).

Cattle tick

Boophilus microplus is a problem in some areas of Australia. If you are transporting goats from a declared cattle tick area there are regulations and control measures to be followed. If ticks are found in declared tick-free zones they must be reported to the Department of

Agriculture or Primary Industries. Cattle ticks themselves are not really a problem for goats unless they have many of them. If goats are heavily infested, the ticks can bleed them dry. Goats in poor condition are more likely to suffer ill effects from cattle-tick infestation.

If the animal has only a few cattle ticks, you can simply pull them off. In the case of heavy infestation, goats can be given a dose of ivermectin: a dose of 7 mL for a 40 kg goat is usually enough. Within two hours of drenching the ticks will fall off and die.
Note: ivermectin is not registered for goats and should only be given under the direction of your vet.

The eggs and larvae live for nine months or longer in the pasture, but their life-cycle on cattle and goats is only about 21 days. They also transmit the tick fever organism, which causes tick fever and death in cattle. During the parasitic stage when they suck blood from the host, the ticks moult through three stages, each of which lasts about a week.

The male ticks feed but do not engorge. They roam about on the host mating with females. During days 14 –21, the female tick becomes engorged with blood then drops onto the pasture and lays up to 3000 eggs, after which she dies. These eggs then hatch and produce larvae that infest pasture, awaiting a suitable host on which to begin the cycle again. The larvae are pinhead size; the nymphs are match-head size and engorged adult females are the size of a pea. Their legs are pale-cream in colour.

Guinea fowl seem to be quite effective in helping to control cattle tick because they eat tick larvae from the pasture. We live in a cattle tick area and have not had ticks since we introduced guinea fowl onto our property 12 years ago. Cattle and goats on neighbouring properties still have cattle ticks sometimes.

Distribution

The cattle tick-infected area of Queensland comprises the coastal areas east of the Great Dividing Range and north of the Northern Rail Line. They are also found in the northern areas of Western Australia and Northern Territory and in the northern rivers area of New South Wales, where they are being eradicated. Cattle ticks are very rare in New South Wales and under the *Stock Diseases Act* 1923 anyone seeing a cattle tick there must report it to the Department of Agriculture (NSW) or the Rural Lands Protection Board.

Under the Stock Act, Queensland is divided into five main tick areas for movement control purposes: the infected area, the free area, the south Queensland protected area, the central Queensland protected area and the north-west Queensland protected area. The protected areas are marginal areas which are generally free of ticks but which can become infected when seasonal conditions are favourable. There are also dedicated eradication areas where producer groups, under Department of Primary Industries and Fisheries guidance, attempt to eliminate cattle ticks. If successful, the areas are added to the protected or free areas.

Before entering tick-free, protected or eradication areas stock from a tick-infected area must be inspected and treated under the supervision of a stock inspector. There are also restrictions on moving stock interstate and stock-owners should contact their local Department of Primary Industries office for details of the relevant regulations.

Due to strict regulations for the transport and handling of stock from tick-infested zones to tick-free zones, the tick zones have shrunk steadily in the past few years. The

cooperation of producers has helped with this, as we all realise that cattle tick infestation can cause not only significant production losses but stock losses too.

Paralysis tick

Ixodes holocyclus, also known as the dog tick, scrub tick or shellback tick, is dangerous to humans, livestock and pets. Many fatalities have occurred as all that is needed to cause death, in a small animal, is one engorged female tick. The tick injects a paralysing toxin that can be fatal unless veterinary attention is obtained.

The life-cycle of the paralysis tick is 135–437 days and comprises four stages: egg, larva, nymph and adult. The adult paralysis tick has a large pointy snout and different leg colours: the first and last pair are brown and the second and third pair are pale.

Paralysis ticks are most active from August to December and, like bush ticks, have three hosts during their life-cycle. They drop from their host, moult then re-attach to a new host twice in their life-cycle. After the third attachment, they drop and lay their eggs. They are called three-host ticks.

Symptoms of paralysis in goats are:

- ascending flaccid paralysis;
- hind limb uncoordination;
- bleat change;
- difficulty with respiration;
- death due to respiratory failure.

Remove any ticks and give to the vet for positive identification. An affected animal will need treatment with antisera (expensive). Canine hyperimmune sera can be used and, if it is given early enough the animal will slowly respond (Baxendell 1988).

Bush tick

Haemaphysalis longicornis, also called the grass tick or bottle tick, is the most common tick in New South Wales. Its legs are dark red-brown. Bush ticks prefer a moist temperate environment and are most abundant where there is thick pasture for protection from extremes of temperature and drying out. They are often found on cattle but will infest any animal, including goats, sheep, dogs, cats, birds and wild animals. Bush ticks do not inject toxin, but can cause problems with 'tick worry' and blood loss if stock are heavily infested.

It is not possible to eradicate bush ticks or paralysis ticks through dipping, backlining or drenching because they spend almost all their life-cycle on pasture and have three hosts including native animals and birds. Control of large infestations is really the only option.

Because cattle ticks spend three weeks of the parasitic stage on cattle and do not attach to native animals, is possible to control or eradicate them. This can be achieved by chemical control, good husbandry practice and strict compliance with stock movement regulations (Baxendell 1988; Martin 2003; Radunz 1997; Jones 1991; Animal Plant and Health Service (Qld) 2004).

Lice

Two kinds of lice commonly infest goats, red biting lice and blue sucking lice (*Linognathus stenopsis*). The red sucking lice (*Damalinia* spp. and *Bovicola painei*) feed on the surface tissue and the blue lice feed on the goat's blood. Lice infestation in goats is normally highest during winter and heavy infestations cause severe irritation to goats, who constantly rub themselves against fences and posts in futile attempts to stop the maddening itch and discomfort. If you see several goats rubbing themselves constantly on fences, it is almost certain that the problem is lice infestation.

In cashmere herds the production loss from lice can be as high as 20%, caused by reduced growth of kids due to their dam's lower milk production (if heavily infested) and lower yields of fleece or down due to lice-egg casings and damage caused by constant rubbing

The two different types of lice, biting and sucking, are found on or near the skin at the base of the hair and are easy to differentiate by sight: biting lice are red in colour and very tiny. The sucking lice are small and blue, the colour due to the blood they have sucked from their host.

The life-cycle of lice takes about 70 days to complete. An adult female produces approximately one egg (nit) per day, that she attaches near the base of a hair or fibre. In about 10 days, nymphal lice hatch. After undergoing three moults during the following 30 days, they are mature and begin laying eggs. They live for approximately 30 days as an adult before dying. They normally spend their entire life on the host and can survive only about a week off the host.

Lice can be spread by infested stock from another property being introduced into the herd, from one goat to another within the herd, from close confinement during transport and from contaminated brushes, combs, blankets or other equipment being reused without being cleaned. Goats can also pick up lice from contact with posts and fences or other things that have been rubbed by lice-infested goats.

To prevent spreading, all new stock should be confined for at least 10 days before being released into the herd. During this time they should be treated with a backline, pour-on or spot-on product suitable for treating lice. Make sure that withholding periods for milk and meat for your target markets are adhered to.

It is usual to use the backline treatments off shears, i.e. when the animal has finished being shorn, apply the backline at the correct rate before the goat leaves the shed. This is most effective in controlling or even eradicating lice in many herds of fleece and down-bearing animals. In stock that is not shorn, we apply the backline with a nozzle designed specifically for the job. Beginning at the base of the tail, hold the nozzle flat on the skin and run it against the natural growth of the hair while squeezing out the measured dose, until you reach the shoulder blades. This treatment should last approximately three months but varies according to the product. For best results stock should be treated twice annually, once in July and again in December.

Some state governments have introduced programs to help eliminate or eradicate lice. 'Licekill' is a program introduced in New South Wales in response to the failure of synthetic pyrethroids to control lice in long-wool sheep. The program offers advice on lice management and alternative effective chemicals.

We have not been able to find any products registered for the control of lice on goats and suggest that you seek advice from your vet.

Mange mites

Though mange is uncommon in goats, it does occur. The two types of mange mites that most often affect goats are *Domodex caprea* and *Psoroptes. Demodex caprea* causes demodectic mange but not alopecia (baldness, unlike sarcoptic mange which does cause alopecia). The clinical signs of demodectic mange are pea-sized nodules usually around the head, neck, shoulders and backline. Because these areas are covered in hair, the nodules are felt rather than seen. Demodectic mange is non-infectious within the herd; animals with some immune deficiency can become infected as young kids (Baxendell 1988).

Diagnosis is done by opening a nodule and removing the thick cheese-like material within, making a smear and examining it under the microscope. Numerous cigar-shaped mites can be seen, similar in appearance to the mites which infest dogs. The vet will prescribe a suitable treatment.

Psoroptes causes the condition known as sarcoptic mange, which has symptoms that most people usually associate with mange – hair loss (alopecia) and itching. The areas most often affected are the head, ears, neck, elbows and, if left untreated, the whole body. Clinical signs are severe pruritus (intense itching), thickened skin, alopecia and swollen peripheral lymph nodes.

Diagnosis must be made by a vet, after looking at skin scrapings from several sites on the affected animal. Several skin scrapings are usually necessary is because it quite difficult to find the parasites. If infection is confirmed, the vet will prescribe a suitable treatment.

Dung beetles and parasite control

A final word should be said on parasites, the chemicals used for their control and their effect on those useful creatures called dung beetles. There are approximately 400 species of dung beetles in Australia, some native and some introduced. Eight species have been introduced into Queensland, the most successful of which are two species of the tunnelling type: *Onthophagus gazella* and *Euoniticellus intermedius.* These appeared in 99% of trapping sites during the Queensland Dung Beetle Project carried out in 2001–02 (Elphinstone 2003).

They were introduced into Australia to help control buffalo fly – heavy buffalo fly infestation in cattle causes hide scarring and loss of condition due to fly worry. The beetles help to break up and disperse or bury the dung of ruminants. This not only controls the breeding of buffalo flies but also helps to reduce intestinal parasites as the eggs and larvae either dry out, killing the worm larvae, or they are buried with the dung and find it difficult or impossible to return to the surface to be ingested by stock.

Some chemicals have an adverse effect on dung beetle populations and should not be used; others can be used but only at certain times of the year to avoid an adverse effect on the breeding cycle.

There are three main groups of parasiticides:

- endectocides – the avermectin group includes ivermectin, doramectin, moxidectin and abamectin. Moxidectin has no known effect on dung beetles. Others in the avermectin group can cause reduced breeding and increased mortality in eggs and

larvae and have their most harmful effects in the dung for two to three weeks after drenching. Some species of dung beetles are more susceptible to avermectins than are others;
- ectocides – for external parasites such as ticks, buffalo flies and lice. Some of these can cause reduced breeding or mortality;
- anthelmintics – albendazole, fenbendazole etc. are used to control intestinal worms and flukes and are not usually considered harmful to dung beetles.

To reduce harmful effects, reduce use of problem chemicals in summer when dung beetle activity is high and use the safer chemicals instead. Chemicals that are known to cause problems should be restricted to times of low dung beetle activity, such as winter.

Dung beetles are a very useful tool in the management of parasites in ruminants and should be considered when formulating a parasite control program. For further information and advice on drenching and dung beetles, contact the Department of Primary Industries or Agriculture (Agforce 2003a, 2003b; Smith and McQueen 2003; Aisthorpe and Edwards 2003; Elphinstone 2003).

11

Poisoning

Goats can be poisoned in many different ways but it usually occurs from the ingestion of a poisonous substance. Some foods or medications that are commonly eaten or used by humans will kill goats and other ruminants. These include a wide variety of things such as avocados (which contain a cardiac glycoside) and loperamide hydrochloride (imodium), used by humans for diarrhoea (imodium paralyses the gut of ruminants, which is usually fatal).

Overdosing when drenching for parasites, especially if the drench contains an organophosphate, can also be toxic to ruminants and many goats have been lost to this.

Overdosing with certain dietary supplements has also caused problems. Two such substances that are only needed in relatively small amounts are copper and selenium. Copper is probably the most commonly overdosed mineral, as it is often deficient in the diet and is given as a supplement in the form of copper sulphate. If it is given in excess, the unused copper is stored in the liver until saturation point, when the copper is released all at once into the goat's bloodstream. Death occurs within a few minutes.

Many plants that are common in domestic gardens or in the field also have toxic properties. Some plants are rapidly fatal if eaten, such as oleander, while some act more slowly by gradually destroying the liver or heart, such as rattlepods (*Crotolaria* spp.) that contain pyrrolizidine alkaloids.

Suspecting that an animal has been poisoned and proving it are entirely different things. Laboratory tests can be done, but as they are very expensive and time-consuming you will need to suggest a causative agent when requesting the test.

The following information covers only the most common of the possible causes of poisoning in goats and is only a guide. Suspect poisoning if:

- animals die suddenly without appearing ill, especially if a group of animals die at the same time;

- ill thrift with no obvious cause over a long period – this can also be due to many other causes, such as Johne's disease;
- profuse salivation;
- foaming at the mouth;
- paralysis;
- convulsions – these can also be due to tetanus or other conditions;
- photosensitisation;
- diarrhoea – this has many different causes.

Plant poisoning

There are about 1000 plant species in Australia known or strongly suspected to be poisonous to domestic animals and humans and several excellent books have been written on the subject of toxic plants in Australia (see Appendix 1). Their clear illustrations and descriptions of plants and growth habits will help you to identify plants in your region that may poison stock.

The most common poisonous plants, the symptoms of poisoning and possible treatment are described below. Some plants are grouped by their poisonous properties, for example cyanide (prussic acid)-containing plants and some by their effects. Some plants will appear more than once because they contain more than one toxin.

Blindness

Some types of ferns cause blindness due to the thiaminase that they contain. Thiaminase is an enzyme that destroys thiamine. This condition, known as cerebrocortical necrosis, is a metabolic disease and is discussed more fully in Chapter 9. Blindness from fern poisoning is a temporary condition –if affected animals are treated and recover, their sight will be normal. Blindness caused by overdosing with closantel drenches for intestinal parasites or from the ingestion of certain plants is permanent. The plant known as nodding blue lily (*Stypandra glauca*) contains the toxin stypandrol and is reported to have caused blindness and stock losses in New South Wales and Western Australia.

There is no treatment for blindness due to closantel overdose or poisoning from ingestion of nodding blue lily because they destroy the optic nerve. Death will result from eating moderate quantities of the plant (McKenzie 1996; Baxendell 1988).

Cardiac glycosides

Plants that contain cardiac glycosides are some of the most toxic in Australia (Dowling and McKenzie 1993; Pearn 1987; McKenzie 1987). The fruit of the yellow oleander (*Thevetia peruviana*) is particularly attractive to stock and children and has caused a number of deaths. All parts of oleanders are highly toxic and it has been reported that as little as one leaf can cause fatal poisoning in stock and humans.

Avocado fruit, or any part of the plant, fed to livestock often causes stock losses. Lactating does that have been poisoned by avocado will have very thick milk with a severe reduction in milk volume for several weeks (Baxendell 1988).

Table 11.1 Plants containing cardiac glycosides

Common name	Scientific name
Red cottonbush	*Asclepias currasavica*
Mother of millions	*Bryophyllum* spp.
Rubber vine	*Cryptostegia grandiflora*
Balloon cottonbush	*Gomphocarpus* spp.
Oleander	*Nerium oleander*
Avocado	*Persea americana*
Yellow oleander	*Thevetia peruviana*

Mother of millions, an escapee from domestic gardens, is found in several forms on roadsides or in paddocks throughout Australia. This plant contains three cardiac glycosides of bufadienolide type (Capon et al. 1985, 1986). This is the same type of poison as found in the skin secretions of the introduced cane toad (*Bufo marinus*), which poisons many native animals and birds unfortunate enough to eat it.

Cardiac glycosides cause death and or degeneration of cells in the heart muscle and if enough damage occurs the animal will die.

Clinical signs of acute poisoning are:

- collapse;
- dyspnoea (difficulty with breathing);
- blue colour of lips and gums;
- death.

Symptoms of less severe poisoning include:

- depression;
- lack of appetite;
- dribbling urine;
- diarrhoea (may contain blood);
- irregular heartbeat;
- lack of rumen sounds;
- death (in approximately five days).

Treatment is expensive and intense, and will need to be done by a vet who will replace fluids lost through diarrhoea and give activated charcoal to absorb toxins in the gut. The vet will also give drugs to help support the heart. Despite this, the animal may still die. Prevention is the best option.

A post-mortem usually shows haemorrhages under the heart membranes and in the intestinal walls, and possibly elsewhere as well. Parts of the lungs may have collapsed and the heart muscle may be pale in patches (McKenzie 1996).

Prevention is not too difficult: most stock will eat these plants only when there is little else to eat. Seek advice from the Dept of Natural Resources or Agriculture for advice on control if you have large infestations of a particular weed. Goats often become poisoned if they are accidentally given cardiac glycoside-containing plants when owners feed them prunings and clippings from the garden. Many properties have avenues of the very attractive *Nerium oleander*, for instance, and fallen leaves can be inadvertently baled into hay.

Cyanobacterial toxins

These toxins, also known as blue-green algae toxins, are produced by several species of algae that include *Anabaena* spp., which cause liver and nervous system damage, *Cylindrospermopsis raciborski* (liver damage), *Microcystis aeruginosa* (liver damage) and *Nodularia spumigena* (nervous system damage). The last will grow in brackish or salt water. These organisms grow in dams and streams that have been polluted by nutrients such as manure and fertilisers that contain high levels of phosphorus and nitrogen. They all cause death by severely damaging the liver or nervous system; death is usually rapid.

Symptoms of algal poisoning are variable but the liver-damaging toxins produce symptoms similar to those of flowering plants (McKenzie 1996).

Sheep poisoned by *Nodularia spumigena* may show the following clinical signs:

- breathing difficulty;
- muscular weakness;
- paralysis;
- nervous twitching;
- coma.

Stock are often found dead near affected water. Sometimes the algal scum can be found on the forelimbs, lips and muzzle (Main 1994).

Toxic algal blooms can be controlled in farm dams by:

- preventing the run-off of water containing high nutrient levels due to manure contamination;
- preventing toxic algal build-up in dams by using barley straw, which inhibits algal growth rates. Tease the straw out of the bales and spread it on the water at the rate of 100 g per 1000 L of water. The difficulty with using barley straw is that it must be placed in the water several weeks or months before the start of weather conditions that will precipitate algal growth. It is not a fast fix and if you have a current outbreak you will need to use one of several other means to treat it;
- simazine, copper sulphate, calcium hypochlorite (pool chlorine) or ferric alum can control or kill the algae. However, not all of these treatments are suitable for use in all situations so you should contact your Department of Primary Industries or Agriculture for instructions on use. Simazine, for instance, is very effective in controlling an algal outbreak but will kill plants, fish, yabbies and other aquatic life and should therefore be used with caution.

If you think you may have a problem with toxic algal blooms, get laboratory tests conducted to confirm the presence of the algae. Your vet or extension officer will tell you how to arrange for laboratory tests. Producers should also contact extension officers to ask about rates of application and state laws governing the use of chemicals for controlling toxic algal blooms in water bodies.

Prevention involves:

- controlling effluent runoff into dams;
- digging deeper dams, which are less likely than shallow dams to be affected by toxic algal blooms;

Table 11.2 Plants containing HCN

Common name	Scientific name
Spotted fuchsia	*Eremophila maculata*
Sugar gum	*Eucalyptus cladocalyx*
Manna gum (new red growth)	*Eucalyptus viminalis*
Linseed/flax	*Linum usitatissimum*
Cassava	*Manihot esculenta*
Cherry, peach, apricot	*Prunus* spp.
Sorghum (when under moisture stress, e.g. from drought)	*Sorghum* spp.

- ensuring that the catchment area is big enough that dams will overflow at least every second year (Main 1994);
- restricting the use of fertilisers near runoff areas to minimise nutrient levels in dams (Main 1994; McKenzie 1996; Dowling and McKenzie 1993).

Cyanide

Some plants that contain cyanide (prussic acid, also known as hydrocyanic acid) are always toxic. Others contain hydrocyanic acid (HCN) only at certain times of the year or when they are stressed from drought. This means that stock may eat the plants with impunity for most of the year, but at other times or in other circumstances those same plants may kill them (Bertram et al. 2005; Ace and Hutchinson 1992; Haenlein 1992d; Dowling and McKenzie 1993; Baxendell 1988).

The most common of these are listed in Table 11.2.

HCN is extracted from the plant during the goat's digestive process. It rapidly enters the bloodstream and blocks the use of oxygen by the cells or body. Because of this, the gums may develop a bluish colour before the goat dies.

Clinical signs do not always appear, as death normally occurs fast (within an hour of the plant being eaten. If symptoms occur, they may include:

- excessive salivation;
- accelerated and deep breathing;
- muscular tremor and twitching;
- staggering gait;
- collapse;
- coma;
- death.

In plants that contain lower levels of HCN and that can therefore be eaten over a longer period, spinal cord damage appears. Affected animals are uncoordinated, have swaying hindquarters and may dribble urine (McKenzie 1996).

Treatment consists of injecting sodium thiosulphate (photographic hypo) into a vein, with water, at a rate of 660 mg/kg, together with a drench of 10–50 g sodium thiosulphate, depending on the size of the animal. The treatment must be given by a vet, because it involves intravenous administration. If you feed sorghum to stock, you should keep a supply of sodium thiosulphate on hand.

To prevent HCN poisoning:

- avoid turning hungry stock in to graze severely frosted or drought-stressed sorghum crops. The more severely stressed sorghum is, the more HCN it is likely to contain. Stock eating large quantities of sorghum can die in as little as two hours. Feed them some hay or roughage first, so that they consume less of the affected sorghum;
- frosted or drought-stressed sorghum should be ensiled, which helps to destroy the poisonous principle (HCN) in the sorghum. Ensiling can destroy up to 60% of HCN in the hay;
- have hay or ensiled sorghum tested for HCN levels before feeding it to your stock;
- give goats a salt lick that contains 10% sulphur, which will help detoxify cyanide in the rumen and liver;
- avoid giving goats access to paddocks where they can eat new growth on manna gums and sugar gums. The young red leaves contain HCN.

A post-mortem may not show any characteristic signs after sudden death, but there may be a fleeting smell of bitter almonds or peach kernels if the paunch is opened immediately after death. The blood may be bright red. Animals with spinal cord damage have microscopic changes in the cord and may have infections of the urinary bladder (McKenzie 1996).

Fluoroacetate poisoning

Fortunately, few plants in this group are of concern to most producers. The main offenders are heartleaf poison bush (*Gastrolobium grandiflorum*) and georgina gidyea (*Acacia georginae*). There have been several reports that feral animals grazing georgina gidyea have developed some immunity to the poison. The poison in these plants is the same as that contained in the 1080 used to control feral pest animals (Clark 1976; McKenzie 1996). It works by blocking the citric acid cycle that is involved in the energy production of cells – the energy supply to cells is reduced far enough that cells cannot function, and die. The poison converts the fluoroacetate to fluorocitrate, which results in major disturbances of the central nervous system and heart. The symptoms take at least 15 minutes to develop but can take several hours to appear. Symptoms may be initiated by fear, stress, or excitement.

Losses in cattle from fluoroacetate poisoning have been estimated at $3.6 million per annum. Losses for other classes of livestock are also quite significant.

There has been research into modifying several strains of naturally occurring rumen bacteria (rumen bugs) whose usual function is to digest plant fibre. Rumen bugs of the species *Butyrivibrio fibrisolvens* and *Bacteroides* sp. have been modified to enable them to detoxify the monofluoroacetate contained in the georgina gidyea and *Gastrolobium* spp. The results of these trials, done by a team from Murdoch University in Western Australia, have been encouraging. Further trials were done in collaboration with CSIRO Scientists from Livestock Industries (Qld), with very encouraging results. The report of the trials has been given to the MLA, and any further action depends upon MLA decisions for funding and Office of the Gene Technology Regulator recommendations for safety testing (Gregg et al. 1998).

Clinical signs:

- animals may be found dead with no previous signs of distress;
- death may result within 15 minutes of the development of clinical signs;
- animals may stagger, tremble, fall and die rapidly with convulsions;
- laboured breathing;
- rapid weak pulse;
- severely affected animals become excited and manic with muscular spasms and convulsions;
- when forced to move, sheep have a hunched back, trembling muscles and difficulty in breathing. They finally collapse. Affected animals may recover if left alone but often die;
- ventricular fibrillation (irregular heart rhythm causing ineffective pumping and eventually circulatory collapse and death) (Clark 1976).

There is no effective treatment for fluoroacetate poisoning and, though affected animals sometimes recover, most die. Eradication of the offending plants and/or limiting access to them is the only means of avoiding poisoning in livestock, unless further development of the modified rumen bugs is completed and they are released for use.

Fungal toxins

Stock can be poisoned when grazing on feed that has fungus or mould. Many moulds and fungi produce toxins which can cause severe liver and organ damage and kill livestock, including goats. Various fungi and moulds develop when conditions are suitable for their growth. In the field, these conditions often include moisture, warmth and a build-up of pasture litter. Mould or fungal toxins in grain or other concentrates may occur if moisture has entered the silo or storage bins before the feed is fed out to the goats. Toxins may even be present in peanut meal, cottonseed or grains when they are purchased; it is sometimes more economical in the long term to pay a little more for feed that you know is from a reliable source.

Aflatoxins (*Aspergillus* spp.) grow on high-carbohydrate feeds such as peanut meal, cottonseed and grains in the presence of warmth and moisture. These toxins cause severe liver damage that often leads to death or long-term ill-thrift.

Clinical symptoms in severe cases:

- depression;
- profuse watery salivation;
- goat appears to be in pain;
- collapse and death.

There is no treatment.

To prevent the growth of fungal toxins, feed must be stored correctly in clean dry conditions.

Post-mortem appearances include:

- the gall bladder is swollen with fluid and may be as large as a grapefruit;
- small haemorrhages throughout the intestinal wall and other organs;
- the liver is mottled with pale patches of dead cells.

Some pasture grasses and plants, such as paspalum, ryegrass and lupins, can host toxin-producing moulds and fungi.

Paspalum staggers is caused by ergot alkaloids present in the fungus *Claviceps paspali*. The fungus infects the seedheads of a number of grass species including *paspalum* spp. and *Cynodon* spp. (couch). Infected seeds are swollen and discoloured black or orange. Most animals recover if moved from the affected pasture (McKenzie 1996).

Ryegrass staggers is caused by lolitrems produced by the fungus *Acremonium lolii.* The fungus lives in the tissues of perennial ryegrass *(Lolium perenne*) and its hybrids. Toxins are concentrated in the leaf sheaths and bases of the grass plants. Most animals recover if moved from the affected pasture (McKenzie 1996).

The clinical symptoms of paspalum staggers and ryegrass staggers are similar:

- goats that seem normal fall when mustered and have difficulty regaining their feet;
- there is fine muscle tremor and slight nodding or swaying of the head.

Facial eczema is caused by sporidesmin produced by the fungus *Pithomyces chartarum* growing in dead pasture litter, usually in ryegrass pastures. Severe and irreversible long-term damage to the bile ducts in the liver is caused by sporidesmin, leading to photosensitisation (sensitivity to sunlight).

Prevention involves avoiding the build-up of pasture litter, by proper management of pastures. For treatment, McKenzie (1996) suggests dosing animals with zinc salts – very carefully, as 'zinc itself is toxic and overdosing will damage the pancreas'.

Lupinosis is caused by the toxin phomopsin produced by the fungus *Phomopsis leptostromiformis* which grows in the stubble of lupin plants. It can also be present in the seed. The toxin may cause photosensitisation due to liver damage and can cause chronic ill-thrift. A vaccine to protect sheep has been developed. It is advisable to consult your vet for further advice about treatment and prevention.

Indolizidine alkaloids

The toxin swainsonine is contained in some plants (Dowling and McKenzie 1993; Dorling et al. 1980). Swainsonine is a trihydroxyindolizidene alkaloid that blocks the body's ability to remove mannose from the cells, interfering with their function. The cells of the nervous system are particularly susceptible (McKenzie 1996). A similar inability occurs in newborn kids who suffer from beta-mannosidosis, where an inherited defect prevents affected kids eliminating mannose from their cells.

Plants containing swainsonine toxin include Darling peas (*Swainsona galagifolia* and *Swainsona canescens*), found in eastern and western Australia respectively. It also occurs in weir vine (*Ipomoea* spp.) and morning glory (*Ipommoea* sp. *aff. calobra*). All parts of the plants are poisonous but the leaves contain 10 times more toxin than the stems (McKenzie 1996). Sheep in the Maranoa district of Queensland have been poisoned by weir vine and we believe that it would have a similar effect on goats.

Animals that prefer these plants will be affected first and most seriously. Hungry stock with limited available feed are more likely to eat sufficient to cause serious problems.

Clinical signs of poisoning are slow to develop but affected animals show signs of nervous system damage:

Table 11.3 Plants that contain liver-damaging toxins

Common name	Scientific name
Avocado	*Persea americana*
Green cestrum	*Cestrum* spp.
Crownbeard	*Verbesina encilioides*
Cooktown ironwood	*Erythrophleum chlorostachys*
Cycads(zamia palms)	*Cycas* spp., *Macrozamia* spp., *Bowenia* spp.
Ellangowan poison bush, Boobialla	*Myoporum* spp.
Lamb poisons (Western Australia)	*Isotropis* spp.
Noogoora burr (seed leaves and burrs)	*Xanthium occidentale*
Yew	*Taxus baccata*

- loss of condition;
- awkward and irregular gait;
- head-shaking and staring eyes;
- uncoordination;
- excitability;
- death after three or four months.

There are no obvious post-mortem characteristics but laboratory examination of cells will show an accumulation of mannose.

To prevent poisoning, move affected animals to pastures free of the offending plants. Pregnant animals should not be grazed on pastures containing these plants but other stock may be grazed in infested pastures for up to four weeks without serious poisoning (McKenzie 1996).

Liver-damaging toxins

Animals eating plants of the type that cause severe liver damage leading to death, have usually eaten enough to kill them by the time you notice symptoms. They may die in the paddock without any outward clinical signs. This happened in the Childers area in Queensland, where eight out of 80 full-blood Boer goats died from eating Noogoora burr. Neurological signs including posterior paralysis, uncoordination and nystagmus were noted in the last sick animal, which was euthanased and autopsied (Dept of Primary Industries & Fisheries, Qld).

Table 11.3 lists some plants that contain liver-damaging toxins.

Clinical signs:

- goat becomes depressed and stops feeding;
- abdominal pain – grinding teeth and kicking at its abdomen;
- sawhorse stance;
- convulsions;
- stumbling gait and apparent blindness;
- within 48 hours of poisoning, animal lies down and becomes comatose;
- death within three days of eating the plant.

There is no effective treatment although drenching with activated charcoal to absorb poison in the gut can sometimes help if the animal has not ingested too much toxin and the poisoning is of recent origin. McKenzie (1996) notes that 'Some animals will recover completely after being mildly affected for a day'.

Post-mortem appearances:

- the liver is swollen and dark red and may look mottled;
- the gall bladder is swollen and filled with fluid;
- jaundice;
- haemorrhages throughout the body;
- excessive fluid around the heart and in the abdominal and chest cavities;
- microscopically, many (sometimes most) liver cells are dead, a change sometimes referred to as acute centrilobular or periacinar necrosis (McKenzie 1996).

The only preventative measures are to limit access to these plants, especially by hungry stock. Do not allow goats to graze paddocks heavily infested with plants containing these toxins, as they may be forced to eat fatal amounts if there is insufficient alternative feed (Dowling and McKenzie 1993; Surveillance 2003).

Nitrate and nitrite poisoning

Cattle, sheep and goats convert nitrate into nitrite in the rumen. Nitrite is absorbed into the bloodstream where it changes the oxygen-carrier haemoglobin into methaemoglobin, which is unable to transport oxygen. Death from oxygen starvation of the tissues occurs when more than 80% of haemoglobin has been converted to methaemoglobin (McKenzie 1996; Dowling and McKenzie 1993; Robson 2003; Baxendell 1988).

Plants accumulate nitrate when the soil level is high but conditions are not suitable for normal growth, which would allow the nitrate to be converted into protein. These conditions can occur at night, during cloudy or cold weather, when plants are wilted, after herbicide application (especially phenoxy-type herbicides such as 2,4-D) or a combination of factors.

During periods of drought, nitrate and nitrite poisoning can be a serious problem. When drought breaks, nitrate uptake by plants may be high, especially in the first week after rain (Robson 2003). Limit stock access to plants that are likely to contain nitrates. Many grain crops will contain nitrates if they have been stressed. Nitrate levels are usually higher in young plants but decrease as plants mature. Most of the plant nitrate is located in the bottom third of the stalk, hence the leaves contain less nitrate and the flowers or grain little or no nitrate (Robson 2003).

Plants that may contain high levels of nitrates include barley, crown beard, johnson grass, mintweed, native couch, oats, rape, ryegrass, sudan grass, sorghum and wheat.

Clinical signs of nitrate poisoning are:

- diarrhoea;
- vomiting;
- salivation;
- abdominal pain.

Clinical signs of nitrite poisoning, appearing 6–24 hours after eating the toxic feed:

- rapid gasping breathing;
- cyanotic gums (bluish or chocolate-coloured);
- convulsions;
- salivation;
- rapid pulse;
- dark chocolate-coloured blood;
- abortion – females surviving poisoning may abort 10–14 days later due to foetal oxygen deprivation;
- death.

Animals may die without showing symptoms.

Treatment: move stock to a quiet place and away from the suspect feed. Immediately call the vet, who may treat the animals with intravenous injections of methylene blue which converts the methaemoglobin back to haemoglobin again. Note: methylene blue is no longer approved for use in food-producing animals by the National Registration Authority for Agricultural and Veterinary Chemicals (NRA). The matter was under urgent review at the time of writing, so consult your vet or the NRA about its use.

Prevention:

- ensiling a crop can help to reduce the amount of nitrate, so that it contains less than in its original state. Forage loses up to 60% of its nitrate content during the process of fermentation;
- prevent access to water that contains high levels of animal waste, decaying vegetable matter or runoff from fertilised paddocks;
- prevent water containing effluent from entering dams and streams;
- control grass and plant growth in yards where high concentrations of urea from urine and manure facilitate the uptake of nitrate. Many animals have been poisoned by eating plants and grass growing in and around stockyards;
- keep the animals happy and healthy – stressed animals or those in poor condition are more susceptible than those in good condition;
- don't graze pastures or crops that may contain nitrates for at least seven days after rain, frost, cloudy days or when pastures or crops are wilted from heat stress;
- don't overstock these types of crops or pastures as the stems contain more nitrate than the leaves. If overstocking occurs, the goats will eat the stems because they run out of leafy material;
- allow only limited grazing of nitrate-containing pastures and crops. Slowly increase the access to grazing that may contain nitrates to allow ruminal bacteria to adapt to the nitrate levels – gradually increase the amount consumed each day;
- be wary of allowing stock to graze crop stubble, especially if it is reshooting;
- don't allow stock to graze herbage or plants recently sprayed with herbicides, especially those containing 2,4-D;
- check nitrate content of plants with commercially available test strips;
- don't give feed supplements containing monensin to stock grazing fodder with a hazardous nitrate level.

Table 11.4 Plants that can cause oxalate poisoning

Common name	Scientific name
Buffel grass	
Curled dock (sorrel)	*Rumex crispus*
Slender dock	*Rumex brownii*
Sheep sorrel	*Acetosella vulgaris*
Elephant grass	
Green panic grass	
Kikuyu grass	
Lamb poisons (Western Australia)	*Isotropis* spp.
Pigweed	*Portulaca oleracea*
Setaria	*Setaria anceps*
Soda bush	*Threlkeldia proceriflora*
Soft rolypoly	*Salsola kap*

Post-mortem appearances of nitrate poisoning are:

- severe reddening and stripping of the stomach and intestinal linings.

Post-mortem appearances of nitrite poisoning are:

- dark-red to chocolate-coloured blood that clots poorly;
- pinpoint haemorrhages in internal organs and on internal surfaces (Robson 2003);
- congestion in liver and kidneys.

Oxalate poisoning

The most common source of oxalate poisoning in goats is the plant commonly known as pigweed (*Portulaca oleracea*), which grows throughout Australia from the inland to the coast. After rain following a dry period, pigweed is often one of the first plants to respond and grows rapidly. Hungry stock may become fatally poisoned by the oxalate and nitrate compounds that it contains. Oxalates are highest in the new leafy growth of plants after rain during autumn, especially if preceded by a dry summer.

Many other plants can also cause oxalate poisoning (Emmerson and McKenzie 2003; McKenzie 1996; VEIN 2004; Dowling and McKenzie 1993).

Small amounts of oxalate can be metabolised by rumen bacteria quite safely, but if the animals eat large quantities of plants containing the toxins rumen bacteria cannot metabolise all of the oxalate and it is absorbed. Oxalate binds calcium in the intestines and the blood, lowering serum calcium levels (Emmerson and McKenzie 2003). Because poisoning is often a combination of the oxalates and nitrates in plants such as pigweed, the symptoms may reflect the toxic effects of both poisons.

Clinical signs of oxalate often resemble those of milk fever, as oxalate binds calcium in the blood:

- muscular tremor;
- staggering and halting gait;
- lying on the side, with legs extended;

- lying on the sternum (breast) with the head forward or turned back to the side;
- bloat;
- subnormal temperature – the ears and interior of the mouth are cold to the touch;
- breathing is shallow and fast;
- heartbeat is weak;
- coma and death within may occur within 12 hours of eating the plant.

You should suspect oxalate/nitrate poisoning if the goats have a history of access to areas containing pigweed or other oxalate-containing plants such as rhubarb leaves or curled dock; if blood tests confirm very low blood calcium and kidney damage; and if the symptoms resemble those of milk fever. In nitrate poisoning, the blood sample will be tinted brown

Treatment is with calcium borogluconate administered as for milk fever (see Chapter 9).

Post-mortem, the vet will take samples of the aqueous humour (fluid from the chamber of the eyeball behind the cornea) for nitrate assay, and a sample of kidney preserved in 10% formalin for microscopic examination for oxalate crystals (McKenzie 1996).

Prevention:

- limit access to paddocks that contain large amounts of these plants;
- increase calcium in the diet by allowing ad lib access to calcium licks such as dolomite. Pregnant or lactating does may be more susceptible to oxalate poisoning, as their calcium requirements are higher;
- calcium precipitates oxalate, which is excreted as it is insoluble. Feed roughage in the form of hay before allowing stock into paddocks with a high percentage of oxalate-containing plants so they will eat less of the problem plants;
- give the goats' rumen bugs time to adapt by allowing limited access to these plants at first. Gradually increase the time that your goats graze the paddocks each day. Stock should graze for only an hour or so the first few times and be fed roughage before release;
- if goats have not grazed paddocks with high levels of oxalate-containing plants for several weeks or months, the process of adapting their rumen bugs to the oxalates will need to be done all over again. The ability to process oxalate is considerably lessened if the goats have been off these feeds for any length of time;
- take care that garden trimmings given as feed do not contain anything from problem plants.

Pyrrolizidine alkaloids

Plants containing pyrrolizidine alkaloids cause long-term and cumulative effects. Goats grazing plants containing these toxins may show no signs of poisoning, but continual grazing over several seasons will often cause losses due to fatal poisoning (Baxendell 1988; Dowling and McKenzie 1993; USDA 2004).

Death results from cell death, mainly in the liver but other organs such as the kidneys and lungs can also be involved. The toxins also stop cells dividing to replace those that are lost due to normal wear and tear. Pyrrolizidine alkaloids can affect the foetus through the

Table 11.5 Some plants that contain pyrrolizidine alkaloids

Common name	Scientific name
Rattlepods	*Crotalaria* spp.
Paterson's curse	*Echium plantagineum*
Common heliotrope, potato weed, caterpillar weed, blue heliotrope	*Heliotropium* spp.
Fireweeds, groundsel, ragwort	*Senecio* spp.

placenta and some are secreted in the milk. There are several reports of foetal and neonatal animals developing liver disease while their mothers were clinically normal (USDA 2004).

Rattlepods are a particular problem, because to inexperienced eyes the plants appear to be a legume (they are) that should be an excellent source of feed (they are not). By the time that goats start dying from the effects of these plants, there will be massive damage to the liver and other organs in a large percentage of the herd. It is a good idea to recognise this attractive plant with its yellow pea flowers and eliminate it from pastures before it becomes established. We know of one unfortunate producer who thought that rattlepods looked liked good potential feed and planted an entire paddock: the results were disastrous, with large stock losses and much time and expense needed to control the infestation.

Paterson's curse is another extremely attractive plant that escaped from a garden. Many stock are lost due to poisoning by this plant. The major losses from poisoning by Paterson's curse usually occur in stock travelling the 'long paddock' in search of feed during drought periods. Stock are poisoned when travelling from a region where the plant doesn't grow, through another where it does. Cattle or sheep eating the plant when they are unaccustomed to it soon begin to show signs of poisoning and by the time that this happens stock losses are usually unavoidable.

Most goats avoid plants containing pyrrolizidine alkaloids as they find them unpalatable, but if other feed is scarce they may be forced to eat damaging amounts of these plants.

Some plants containing pyrrolizidine alkaloids are listed in Table 11.5. There are over 160 known pyrrolizidine alkaloids in plants, all of which are capable of causing cell damage and death if sufficient quantities are eaten.

Clinical signs of acute poisoning, when large quantities are eaten in a short time:

- laboured breathing;
- collapse and rapid death.

Clinical signs of chronic poisoning, when smaller quantities have been eaten over a longer period:

- poor growth;
- weight loss;
- weakness;
- aimless wandering;
- ataxia – staggering gait;
- apparent blindness;
- scouring and possible rectal prolapse;
- recumbency and death.

Table 11.6 Some plants that cause photosensitisation

Common name	Scientific name
Plants that cause primary photosensitisation	
Meadowsweet, bishop's weed	*Ammi majus*
St John's wort	*Hypericum perforatum*
Plants known to cause secondary photosensitisation triggered by liver damage	
Boobialla, Ellengowan poisonbush	*Myoporum* spp.
Lantana	*Lantana camara*
Grasses and plants with liver-damaging steroidal saponins capable of causing photosensitisation	
Bambatsi panic, french millet	*Panicum* spp.
Koronivia grass, signal grass	*Brachiaria* spp.
Caltrop, devils thorn	*Tribulus terrestris*
Rape	

Affected goats may not show all symptoms and many of the symptoms can resemble those of other conditions. If a number of goats appear to be affected, a vet should be consulted so that a proper diagnosis can be made. Certain characteristic changes will be found in the blood of affected animals if samples are taken.

There is no known treatment for this type of poisoning and affected animals usually die due to liver cell death, interfering with normal liver function, and because of damage to other vital organs and blood vessels.

Prevention:

- deny hungry goats access to heavily infested pastures;
- if necessary, fence off areas containing large quantities of these plants;
- take steps to control these plants in pasture;
- contact the local Department of Primary Industries or its equivalent for advice on control measures with a view to reducing or eliminating problem plants from your property.

Photosensitisation

Many plants contain substances that can cause photosensitivity. In some plants the causative agent is contained in the pigment (primary photosensitisation) but in other cases the photosensitivity is secondary to liver-damaging toxins (secondary or hepatogenous photosensitisation) (McKenzie 1993; Baxendell 1988; Ace and Hutchinson 1992). Animals that are especially vulnerable to this condition are white or pale-skinned goats, such as Saanen dairy goats or angora and cashmere goats with white fleeces bred for lack of pigmentation. These goats suffer terribly from ingesting any quantity of photosensitising plants if they are grazing in bright sunlight with no shade, and often die from the effects.

Some legumes can also cause this condition in susceptible animals.

Urea poisoning

Urea poisoning is not uncommon in goats, especially where goats and cattle are run on the same property (Baxendell 1988; McKenzie 1996; Chenost and Kayouli 1997). The reason is

that cattle are often fed urea as a readily available non-protein source of nitrogen. Goats can also be fed urea as a supplement but they require much less than cattle, due to their much smaller size and bodyweight. Consumption should not exceed 15 g per day. Doses of urea higher than 1–1.5 g/kg of bodyweight are usually fatal to ruminants.

Problems with urea poisoning arise when goats gain access to molasses intended for cattle. Goats unaccustomed to molasses often gorge on it. This can cause problems such as enterotoxaemia or CCN, but if the molasses is fortified with urea they may also be poisoned by it. Goats can also suffer urea poisoning if they drink the liquid prepared for fortifying poor-quality hay during drought or by eating hay prepared in this manner before it is completely dry. If the mixture is not evenly spread on the hay and a goat receives a high concentration of urea, intoxication can result. If a goat drinks a good draught of the liquid prepared for fortifying hay it could ingest approximately 100 g of urea; if it is not found and treated promptly it will die.

Another source of poisoning is pools of water and urea that form in the hollows of mineral blocks, created by stock licking them. Mineral blocks should always be kept in a sheltered area, or a small shelter built over them if they are in the paddock, to prevent rain or heavy dew accumulating in the hollowed tops.

Goats and other animals need time for their rumen bugs to adapt to any non-protein source of nitrogen. A large amount of urea ingested by a goat that is unaccustomed to it is usually fatal because it causes a high concentration of ammonia in the rumen; if the concentration is too high it is absorbed into the bloodstream. Symptoms of poisoning may appear as little as 20 minutes after ingestion of the urea and unless treatment is promptly administered the animal will die.

Clinical signs of mild urea poisoning:

- dyspnoea – difficult or laboured breathing;
- colic;
- bloat.

Clinical signs of severe poisoning:

- uncoordination;
- muscle tremor;
- depression;
- excessive salivation;
- severe abdominal pain;
- hyperaesthesia – abnormal sensitivity of skin or other sensory organs;
- tachycardia – irregular heartbeat;
- convulsions and death.

Treatment for urea poisoning is aimed at:

- slowing the absorption of ammonia from the rumen into the bloodstream;
- reducing the high pH levels in the rumen by giving oral drenches of an acidic solution of vinegar and water.

To be effective, the drench (50% vinegar and 50% water) must be administered as soon as symptoms appear. Depending upon the goat's size, 500–1000 mL of the solution should be adequate. If vinegar is not available, lemon juice can be substituted. However, if stock on your property are being fed urea, vinegar should always be kept handy in case of accidental poisoning.

Post-mortem signs of urea poisoning are an alkaline rumen pH and high levels of ammonia in the blood.

12

Marketing

In Australia, goat meat and live goats have become valuable exports. The export of breeding stock in the form of South African Boer bucks and does, mainly to Asian markets, has slowly grown. While the export market has been doing reasonably well for a number of years, the domestic market is still in its infancy and will need a lot of time and effort to develop. Educating the Australian public to accept goat meat as the tasty, high-protein and low-cholesterol product that it is will take some time, as the general public in Australia perceives goats as smelly animals with rancid strong-tasting meat. Nothing could be further from the truth, as millions of Asians, Africans and Europeans can attest.

Efforts have been made to educate the Australian public about goat meat with free tastings and cooking demonstrations at regional shows and field days, but much still needs to be done before the public accepts goat meat as a regular part of the diet. Goat meat is consumed throughout the world and is the principal source of protein in many developing tropical countries (Kellaway 1999).

Some 1998 surveys assessed the feral population of goats at more than 4 million head, but that population will soon drop significantly due to continuing drought and harvesting for the export market. The shortage of well-finished and market-ready animals has driven the development of on-farm breeding programs.

Table 12.1 compares the carcass composition of goats and other animals.

Because goats are seasonally polyestrus (breeding in autumn and winter) the reliable supply of goat meat year-round is a problem for both the domestic and export markets. Restaurants are often reluctant to add goat meat to their menus when a reliable supply of consistent quality cannot be guaranteed.

The former problem is addressed by some producers with the use of artificial insemination and embryo transplant programs to ensure a consistent supply of slaughter goats throughout the year. The introduction of South African Boer goat genetics has been helpful in this respect, as they breed naturally throughout most of the year.

Table 12.1 Carcass composition of different animals (% of carcass weight)

	Goats	Sheep	Cattle	Pigs
Muscle range	65 (55–68)	55 (45–65)	60 (50–70)	50 (35–64)
Fat range	20 (6–24)	30 (8–40)	25 (10–35)	38 (25–45)
Bone range	15 (12–22)	15 (7–24)	15 (9–20)	12 (8–16)
Cholesterol: mg/100 g	5–39	52–77	42–78	66–98

Source: Department of Primary Industries & Fisheries (Qld) (1998)

The problem of consistency of quality is being addressed by some producer groups and cooperatives by feedlotting or grain-assisting wethers and bucks destined for slaughter. There are several feedlots, but as they have been operating for only a short time their impact on the market is still to be felt.

The export market for goat meat has been variable since the mid 1990s. The export of goat meat to some countries has steadily increased, with the US increasing its imports from approximately 3000 tonnes in 1997 to over 5600 tonnes in 2001–02. In other countries such as Taiwan, the market fell from a peak of approximately 7700 tonnes in 1994 to around 4500 tonnes in the 2001–02 periods. This market fluctuation makes forward planning difficult for producers and attempts are being made to address the problem. In Western Australia, Landmark is forward-contracting a guaranteed price for premium quality kids for the capretto market. This makes production planning much easier because producers know how many kids they are required to turn off, the weights required, when they are required and the price. There are penalties for non-supply or late supply of product.

Marketing your goats begins long before you actually load your first shipment for sale. When you have decided the market to which you will target your production, your work is just beginning. There are many factors to be taken into account and a good deal of

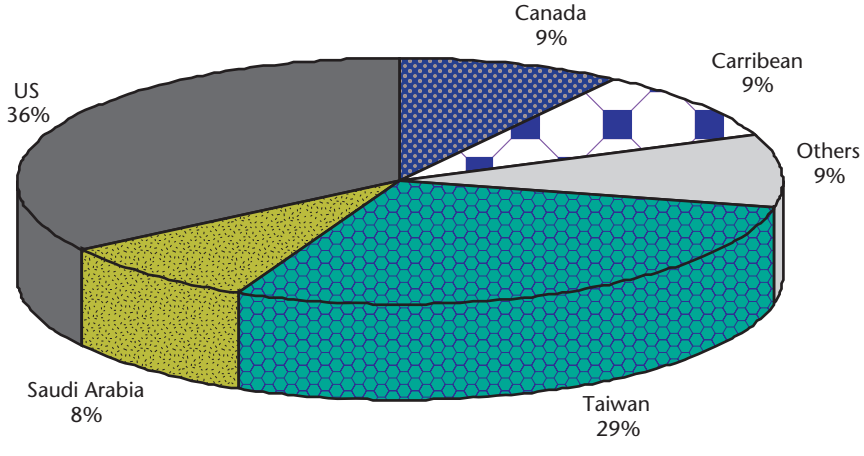

Figure 12.1 Value of Australian goat meat exports

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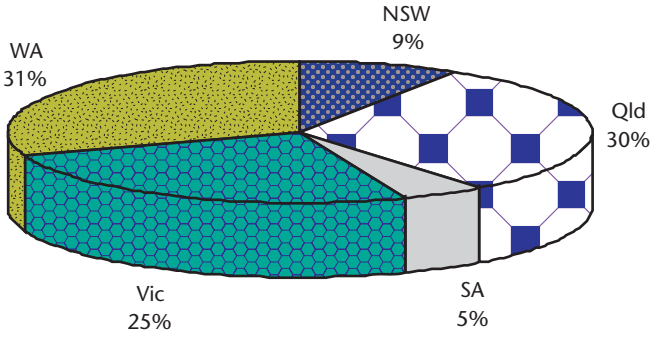

Figure 12.2 Goat meat exports by state

Reproduced courtesy of Meat and Livestock Australia

preparation to be done long before you will have a shipment of goats ready for your chosen market.

In a country such as Australia, that is dry and with mostly poor soil, it is rare to have high-quality feed available in the paddock year-round. This means that forward planning for feed quality, price and availability during the period prior to selling your goats is imperative. For instance, it is good management practice to buy hay or chaff in summer when it is plentiful and inexpensive rather than in winter, when it is usually scarce and very costly. This allows you to maximise your profit, instead of spending it on feed.

Most markets, domestic or export, require goats to be in condition score 2–3 in a range from 1 (very lean) to 5 (very fat). Very fat goats are not acceptable in any market and neither are very lean animals. Condition score 0 (zero) is seen in starving animals during drought

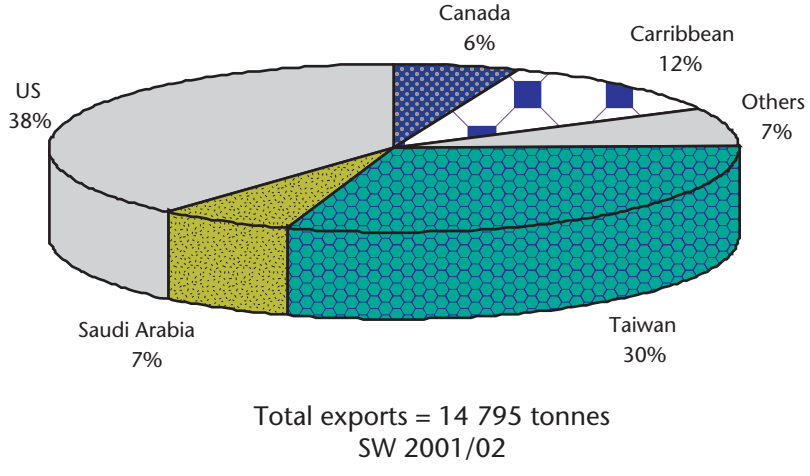

Figure 12.3 Destination of Australian goat meat exports

Reproduced courtesy of Meat and Livestock Australia

or on severely overstocked properties. Animals in this condition often die; if they survive they rarely recover fully even when given access to good feed (see Chapter 8).

The following section is reproduced with the kind permission of Suiter (1994) and the Department of Agriculture (WA).

Body condition scoring

The condition and nutritional status of livestock can be measured by liveweight change and body condition scoring. Liveweight change, using liveweight scales, is the most accurate way of measuring the condition of livestock except during late pregnancy or when gutfill varies between each weighing (Agdex 430/26) At these times, condition scoring is a useful additional method to liveweight change.

Where liveweight scales are not available, condition scoring is the best alternative. Visual appraisal is unreliable and is easily confused with gutfill, length of fleece and pregnancy. Condition scoring can be used:

- to assess whether more feed is needed to maintain or increase condition and liveweight;
- in meat production systems where a particular carcass finish is desired by the consumer.

Carcass finish is assessed as a fat score which is directly related to the condition of the live animal – carcass fat score 3 is equivalent to condition score 3. In both the sheep and goat meat industries body condition scores of 2–3 are desirable (well-finished but not fat). Condition score 1 animals are unfinished (muscle development is poor), while animals in condition scores 4–5 are overfat and unacceptable to all known markets. Condition score 5 (very fat) is rare in goats.

Use of condition scoring

The condition scoring system was developed for sheep but it can also be used for goats. Condition scoring is done by feel. Accuracy improves with practice. When feeding for survival or for maintenance of body condition during periods of feed shortage, the livestock should be maintained at a condition score of 2. Below condition score 2, wool production in sheep is likely to be affected, with the development of tender fleeces. At condition score 1 or below the animal is emaciated and its long-term production may be reduced. In a breeding ewe or doe, condition scores near 3 are desirable. Lower scores will result in fewer lambs or kids being born, lower birthweights and thus lower survival rates.

How to condition score

Condition score is independent of body size, i.e. animals of capretto size (small lambs) and of shipper wether size can have the same body condition score. Condition score is a measure of the amount of soft tissue (meat and fat) over the bones, not of the size of the animal.

The animal should be standing in a relaxed position. It should not be tense, crushed by other animals or held in a crush. If the animal is tense, it is not possible to feel the short ribs and get an accurate condition score.

Figure 12.4 Position of the 13th rib in a goat

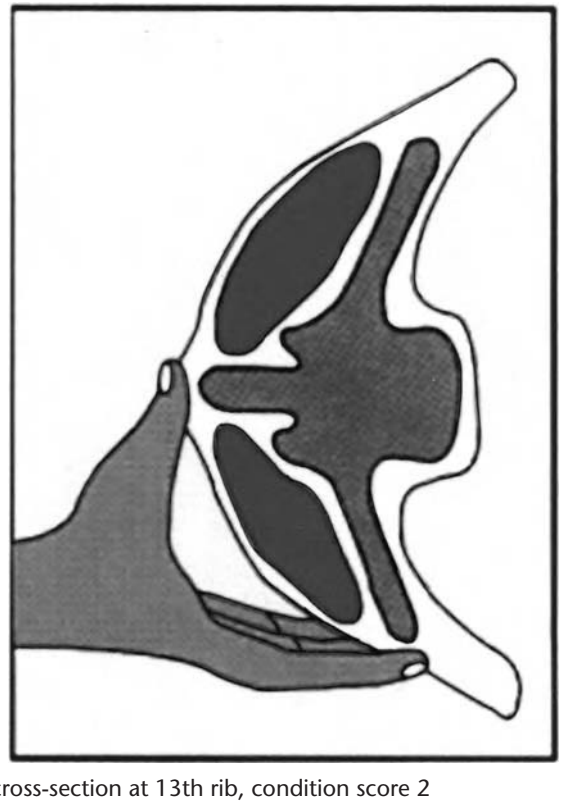

Figure 12.5 Sheep cross-section at 13th rib, condition score 2

Source: Department of Agriculture (WA)©

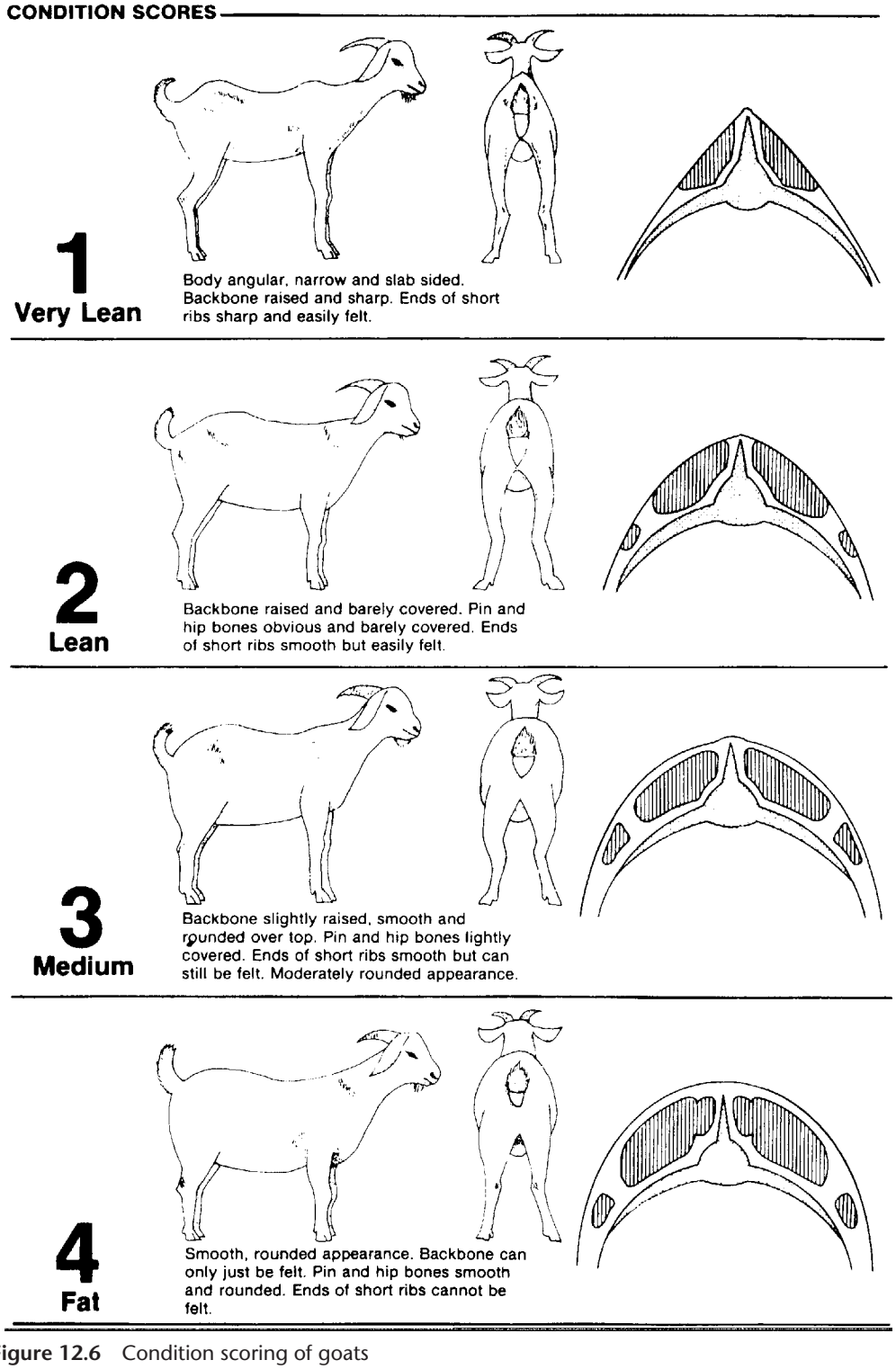

Figure 12.6 Condition scoring of goats

Source: Mitchell (1986). Reproduced with the permission of Department of Agriculture (NSW)©

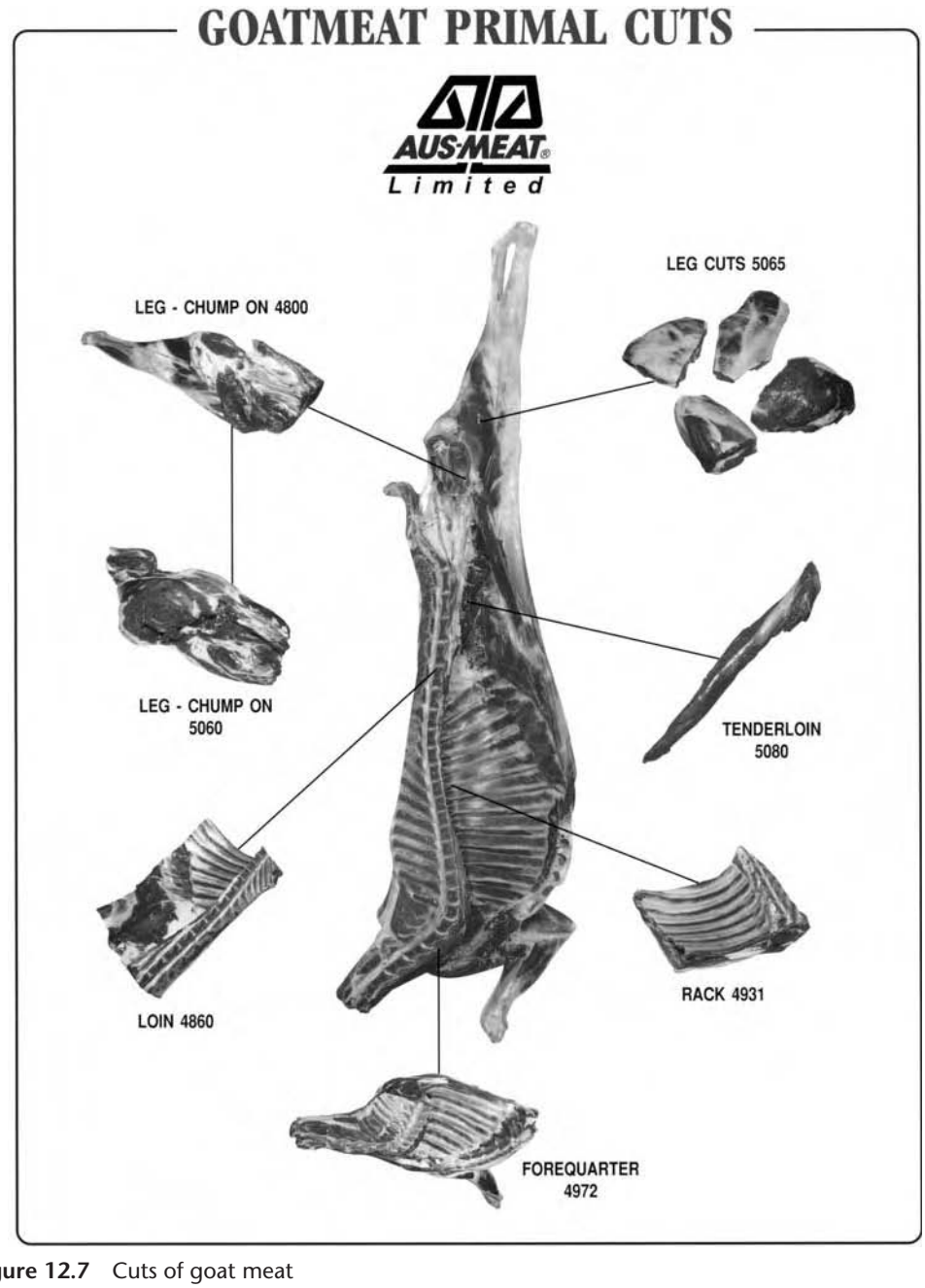

Figure 12.7 Cuts of goat meat

Source: Ausmeat Ltd. Reproduced with permission

Locate the last rib (the 13th) and use the balls of your fingers and thumb. Feel the backbone with your thumb and the end of the short ribs with your fingertips, immediately behind the last rib. Figure 12.4 shows the position of the 13th rib in a goat; Figure 12.5 shows the cross-section of a sheep (condition score 2) at the 13th rib. Condition scores 1–4 are shown in Figure 12.6. Figure 12.7 shows the various cuts of goat meat.

Markets and market requirements

Each market, domestic or export, has specific requirements for dressed carcass weights, skin on or skin off, condition scores and age. So that there is no confusion between producers and processors, a definition of a standard carcass has been developed and is used by most of the industry. The following standard carcass definition has been supplied by Ausmeat® Ltd and is copyright.

Standard carcass©

Other than skin-on goat carcasses, a goat carcass is the body of a slaughtered caprine animal after:

- bleeding;
- skinning;
- removal of all the internal digestive, respiratory, circulatory, excretory and reproductive organs;
- minimum trimming as required by the meat inspection service for the carcass to be passed fit for human consumption;
- trimming of the neck and neck region may be extended to ensure compliance with 'zero tolerance' for ingesta contamination, especially where halal slaughter has been performed. This extension to the standard carcass trim is limited to a hygiene trim but may include complete removal of the first cervical vertebra. This process must be controlled by the company MSQA program.
- The following should also be removed:
- head between the skull (occipital bone and first cervical vertebra);
- feet between the knee joint (carpus and metacarpus) and the hock joint (tarsus and metatarsus).
- tail so that it is no longer than five coccygeal vertebrae;
- thick skirt by separating the connective tissues as close as possible from the bodies of the lumbar vertebrae;
- kidneys, kidney knob and the pelvic channel fat;
- udder, or the testes, penis and udder or cod fat.

The carcass must be weighed hot (HSCW). The Ausmeat standard carcass applies to all over-the-hooks trading in Ausmeat accredited abattoirs unless a variation is agreed to by the producer and processor. In this case, the term non-standard carcass must be stated on the feedback sheet.

Domestic market

The domestic market is perhaps the most varied and can be broken down into the following major categories:

- butchers;
- supermarkets;
- restaurants;

- on-farm live sales, which are mainly to ethnic groups for private kills;
- sales to abattoirs that specialise in halal kills for the Muslim community;
- breeding stock either as replacements or for improved herd genetics.

Each market has its own requirements. If you cannot meet these consistently you are unlikely to get repeat orders.

Butchers and supermarkets

Butchers in Australia usually require goats that are either grain-fed or grain-assisted, are first or second South African Boer goat crosses, aged 9–12 months and with an average carcass weight of 14–22 kg for chevon and 6–12 kg for capretto.

Supermarkets have similar requirements to butchers but demand even more consistency of product. Some ethnic butchers also produce traditional sausages and salamis using older and leaner animals.

Because range-fed animals sourced from different areas vary so much in fat content and tenderness, both of which make a difference to eating quality, some co-ops have set up feedlots to enable product standardisation.

Restaurants

Restaurants using goat meat are of two main types:

- silver service – likely to serve capretto (kid) as roasted meats and dishes requiring younger and tenderer cuts. These restaurants also use some 2–4 tooth chevon (young adult) goat meat in the form of curries, braises and stews;
- ethnic – likely to require chevon 2–6 tooth, as they mainly use moist, long, slow-cooking methods. Many of these restaurants prefer older animals, believing that they have better flavour than younger animals and a better texture for the cooking processes involved in curries, braises and stews. Meat from very young animals tends to disintegrate during long slow cooking.

The hotel and restaurant trade use young animals for roasting in the form of racks, loins and saddles.

On-farm live sales

On-farm live sales are mainly to people of Middle Eastern, Indian and Asian origins, and to members of the Italian and Greek communities. They often use goat parts that are not readily available in butcheries, such as the intestines (for making sausages) and the udder, which is prepared similarly to tripe. The bile and reproductive organs are also used. People of Italian descent often want young milk-fed kids (six weeks old or less), as a traditional Italian type of cheese can be made using the stomach of the kid. The carcass of the young kid is usually roasted entire.

Halal meat

It is estimated that there are approximately 1.4 billion Muslims throughout the world and 300 000 Muslims in Australia, all of whom represent a potential market for goat meat as there is no religious prohibition of its consumption. However, all meats consumed by Muslims must be slaughtered in the traditional halal way. Halal means 'lawful' in Arabic,

and for meat to be identified as halal it must be slaughtered by a Muslim in accordance with the requirements of Islamic law.

The Muslim market is a large and important one for Australian meat companies and they have strict procedures to ensure adherence to all requirements for the halal slaughter and handling of meat. Various registered Islamic organisations supervise the slaughter, preparation and handling of animals to ensure the maintenance of Australia's reputation as a producer of meat according to halal requirements.

In 1983, the Australian Quarantine Inspection Service (AQIS) introduced the Australian Government Supervised Muslim Slaughter program (AGSMS) to control the production of halal meat and meat products. AQIS controls the AGSMS program and has recognised a number of Islamic organisations that are responsible for the provision of halal inspection, supervision and certification services for meat and meat products. As well as ensuring only practising Muslim men perform the slaughtering and supervisory work, these organisations provide guidance and expertise on Islamic shari'ah and interpretation of halal principles (Ausmeat Ltd).

In most Asian countries the consumption of goat meat is higher in winter, so the market is likely to be seasonal. The market for live goats and goat meat to the Muslim community is greater in the period of Ramadan when goat meat is traditionally consumed.

Abattoirs

There are several large abattoirs slaughtering goats for the export market, but goats killed for the domestic market are generally slaughtered as service kills by smaller abattoirs for goat producers' cooperatives that supply butchers, restaurants and supermarkets. These smaller abattoirs also do service kills for private butchers and individuals on request.

There are a number of mobile butchers that do on-farm service kills for producers and some of these specialise in halal kills. In Queensland there is a mobile halal slaughterman who supplies and slaughters goats on-site for Muslims (Powter 2004), who are thus assured that the meat they are eating has been slaughtered using the correct traditional methods.

Feedlotting

It may be worthwhile investigating co-ops that specialise in feedlotting. It can be more economical and bring higher returns if goats are put into a feedlot to be finished for sale. Feedlots can usually purchase their feed at a discount of 7.5% or more, because they buy forward contracts in hundreds of tonnes. The entry weight for goats into feedlots varies. One feedlot in Queensland, for the domestic market, requires a minimum of 40 kg and its turn-off weight is approximately 45 kg. Goats are kept in the feedlot for 21 days and fed a carefully formulated diet calculated to put on exactly the correct amount of muscle and fat required by the target market (usually Queensland butchers).

Weights required for entry into most feedlots are lower than the above example, usually approximately 30 kg, with goats considered finished and ready for slaughter at around 35 kg. Most exporters prefer to purchase goats for feedlots at approximately 30 kg. For members of producers' cooperatives, charges in feedlots are often calculated on a daily basis as animals reach market weight at different times, depending upon their entry weight and genetics. However, some feedlots charge a flat rate and may also charge a fee for delivering animals from the feedlot to the abattoir. Export companies usually purchase goats outright from the producer and bear the costs of feedlotting, transport and slaughter etc.

Further information on feedlotting is available in two Department of Primary Industries & Fisheries (Qld) notes (Flint and Murray 2004a, 2004b) which clearly explain everything necessary for setting up and running a feedlot. These notes are available on request from the Department itself or may be downloaded from the website: http://www.dpi.qld.gov.au.sheep.

Domestic goat meat products

Bone-in cuts

Unless they are from very young animals such as milk-fed kids, bone-in meats are often cooked using moist, slow cooking methods. Capretto from milk-fed kids may be roasted like lamb or, in the form of chops, may be broiled or fried. Chevon may also be roasted and best results are obtained when it is cooked slowly in an ovenbag or potroasted for three or four hours (until tender) in a covered baking dish or casserole, that has some water in the bottom of the dish. Bone-in legs of chevon may be pickled (pumped) in the same way as mutton and simmered until tender. This has become quite popular in southern Queensland in recent years.

Meat and Livestock Australia suggests the following bone-in cuts as defined in its cuts and specifications guide:

- bone-in leg;
- bone-in rack;
- bone-in leg chops;
- bone-in shoulder;
- bone-in shank;
- bone-in shoulder chops;
- bone-in saddle;
- bone-in ribs and flap;
- bone-in loin.

Bone-in leg and bone-in leg chops are popular items that are often requested by the Greek and Italian communities in the Sydney region (Miller 1998).

Bone-out cuts

Bone-out cuts offer convenience and ease of preparation and may be similar to those used for lamb and mutton. The cooking methods used for goat meat are somewhat different for chevon (adult 2–4 tooth goat meat) than those used for mutton, in that usually chevon is prepared using moist, slow cooking methods whereas mutton is often roasted.

Capretto (milk-fed kid up to 12 kg carcass weight) offers more flexibility and most of the following bone-out cuts can be used for capretto. Meat and Livestock Australia suggest the following bone-out cuts for goat meat:

- boneless leg (shank off);
- boneless leg rolled (netted);
- boneless leg cuts;
- boneless leg cuts (special trim, denuded);
- boneless leg cuts (special);
- boneless backstrap (eye of saddle);
- medallions and paillards;

- boneless saddle (rolled and netted);
- boneless eye of loin (denuded);
- boneless saddle;
- boneless shoulder;
- meat strips;
- boneless tenderloin;
- diced meat.

Bone-out cuts are also used to make smallgoods such as sausages and salami.

Capretto

Capretto is young milk-fed kid and is very tender with a pale colour and a fine texture. Kids for the capretto market should not be weaned before marketing. Once the kid is weaned, the connective tissue begins to change and by the time a goat is 12 months old the flesh has darkened, is much less tender and requires different cooking methods from those used for capretto (milk-fed kid). Capretto is much sought-after by people of Greek and Italian descent and there is a thriving domestic market for it in southern Australia, for these communities and for the hotel and restaurant trade. The season for prime capretto is between October and March. When purchased as a whole carcass it may be stored 1–10 days when chilled correctly, or up to three weeks if it is vacuum-packed and chilled.

The criteria for capretto as defined by Ausmeat are:

- young milk-fed kid;
- carcass weight up to 12 kg – carcasses are usually 6–12 kg;
- fat score 2;
- non-feral – the origin infers some expectation of body condition and is not a genetic discrimination (Miller 1998).

Another market for capretto is whole carcasses purchased for religious ceremonies and family festivities by ethnic communities in Australia. It is typically roasted either as a whole or half carcass, in a medium to hot oven.

The domestic goat meat market is still very much in its infancy and producers have few reliable outlets. There are several producers' co-operatives that have been doing a great job of marketing and promoting goat meat as an alternative to beef and mutton, but a lot of work still needs to be done.

If you would like to sell goats into the domestic market, begin by ringing abattoirs in your area, canvassing butchers and advertising live goats for on-farm sale in the press, especially magazines and newspapers aimed at ethnic readers. A number of buyers advertise in periodic newspapers and journals. Contacting producers' cooperatives such as Ausgoat or Qgoat is another option. Local goat producers' groups, which have been growing in popularity in recent years, are also a good source of information and marketing contacts. Government Departments or industry groups such Ausmeat, the MLA and the Department of Agriculture or Primary Industries are other good places to start (see Appendix 1).

Export market

Australia is not the biggest producer of goats but it is by far the largest exporter. Many countries such as China, that has approximately 160 million people, have vast inventories of

goats but the production is mainly used domestically and China itself still imports over 5000 tonnes of goat meat per annum.

Export facts and figures:

- 31% of goat meat exports are shipped from WA and 30% from Queensland;
- although Australia is a relatively small producer of goat meat on a world scale it is the largest exporter;
- in 2001/02 Australia exported 14 795 tonnes of goat meat;
- the value of Australian goat meat exports in 2001/02 was $A45.7 million FOB (ABS);
- Australia exports approximately 173 tonnes of goat offal annually, much of it to Asia;
- in 2001/02 Australia exported 138 781 head of goats (ABS) – the largest market was Saudi Arabia, followed by Malaysia and Singapore;
- the majority of live goat exports are shipped from Western Australia (46.1%) and Victoria (35.9%);
- live goat exports were valued at $A8.9 million in 2001/02 (ABS).

On-farm breeding of goats is an expanding industry: many smaller landholders are setting up goat meat breeding enterprises and some cattle and sheep producers are diversifying their grazing production to include goats. Supply of on-farm bred goats for the export market cannot keep up with the demand. However, prices are variable and seasonally driven. The peak export market is between June and October, coinciding with various religious festivals where goat meat is part of the cultural and religious observations of many ethnic groups. Goat meat is also exported to Asian countries where it is mainly eaten in winter, because it is considered a 'heating' meat. Taiwan sources 90% of its carcasses from Australia and requires lean skin-on animals

Australia's largest market for goat meat (38.6% in 2001/02) is the US. This market has been growing steadily for a number of years, partly due to the increasing number of ethnic restaurants. Many exporters now export goat meat to both the east and west coasts of the US, mainly for the restaurant trade and the ethnic market. If current trends continue, the future of the US market looks certain. Several other countries, notably the Caribbean (Barbados, Trinidad, Jamaica, Curacao and Guadalupe), Saudi Arabia and Canada also import significant amounts of Australian goat meat.

In the Middle East, Australia must compete with Iran and Somalia to supply live goats to the United Arab Emirates, the world's largest live goat market. Western Australia exports the largest number of live goats (46.1%), closely followed by Victoria (35%). The two states exporting the largest tonnages of goat meat are Western Australia (30.6%) and Queensland (30.6%), closely followed by Victoria (25.2%). Total goat meat exported in 2001/02 was 14 795 tonnes. Exports of goat meat as chilled or frozen carcasses and as six-way cuts in 2001/02 added almost $A46 million FOB (free on board) to the Australian economy – not an insignificant figure and certainly a worthwhile contribution to Australia's export industry.

Capretto for the export market

Wesfarmers Landmark in Western Australia has been selling capretto to both the domestic and export markets since the early 1990s. Originally it sold surplus kids from the cashmere market; it now sells 12 000–20 000 carcasses per annum in whole or broken form, with a weight range of 4–9 kg.

Table 12.2 Traditional holidays and festivals when goat meat is eaten

Holiday or festival	Date	Requirements
Western or Roman Easter (Italian community)	March–April (festival date varies)	Capretto: milk-fed kids Dressing 4–9 kg Well-fleshed Not weaned before sale
Eastern Easter (Greek Easter)	April–May (festival date varies)	Slightly heavier kids are preferred Dressing 7–12 kg Not weaned before sale
Navadurga (Dashara) (Hindu festival honouring the goddess Durga)	12 October 2005 (festival date varies)	Male goats only, tender Goats are slaughtered on the 7th to 10th day of the festival after which families meet and celebrate with curried goat while receiving family blessings
Ramadan (Muslim festival)	Begins 4 October 2005 (festival date varies)	Live weight wanted 27 kg Dressed weight @ 47% HCW: approx. 13 kg Male and female kids with all their milk teeth, i.e. no older than 12 months Males may be castrated Goats must not be overly fat (condition score 2–3 preferred)
Id al Fitr (breaking of the Ramadan fast)	14 November 2005 (festival date varies)	Same as for Ramadan
Id al Adha (Festival of Sacrifice)	21–24 January 2005 (festival date varies)	Yearling animals with one set of adult teeth (2 tooth) that are blemish free Animals that have broken horns, wounds or other physical damage or that are unsound, are rejected Castrated goats or goats with docked tails are not acceptable Goats 27–45 kg live weight

Note: A dressing percentage of 47% has been assumed in the HCWs (hot dressed carcass weights).

Other Australian companies also export capretto to Europe, with one Queensland-based company selling approximately 10 000 capretto carcasses each year into the Swiss market. We believe that there is room for expansion in the capretto market. France, for instance, supplies 100 000 kids per annum to the European capretto market.

Kids from Australia are shipped in October and December ready for peak requirement times (see Table 12.2).

Other markets

Australia has exported goat meat to the skin-on market in Taiwan for a number of years and this is the second-largest destination for our goat meat exports. This market is open only six months of the year because, traditionally, goat meat is only eaten in Asian countries during the cooler months. Lean animals with a condition score not higher than 3 are preferred and strongly flavoured meat such as that of bucks is discriminated against. Other markets in the region are Malaysia and Singapore, which fluctuate from year to year but in 2001/02 were the largest live goat export market (after Saudi Arabia). The market in other Asian countries is being explored with a view to further development.

Australia has exported goat meat into the Caribbean market for a number or years. This market prefers strong-flavoured, smelly young bucks, but the Australian market is more

likely to supply frozen carcasses than live goats – the US supplies those. The Caribbean has two main goat meat consumption periods. The first is for capretto (young milk-fed kids) at Christmas. This market could be worth further examination by Australian producers and exporters as Australia can produce capretto (from autumn matings) to meet this market more readily than producers in the northern hemisphere. The second period of major consumption is during August, when various festivals such as Carnival and Jamaican Independence Day are celebrated.

Australia mainly exports goat meat into the Caribbean markets as frozen six-way cuts – two loins, two legs and two shoulders, packed into cartons and frozen for shipment. A shipping container can take approximately 13.5 tonnes of six-way cuts.

A market exists for boned-out goat meat in the Caribbean but it is not viable for Australian exporters due to the cost of production, which is around $8 kg FOB, compared to the buyers' price of $5–6 kg. If production costs can be reduced and the prices offered by purchases become higher, exporters may be able to take advantage of this market.

Preparing goats for market

Marketing your goats begins with research. You must research your markets well in advance, but be flexible because market requirements and markets themselves are constantly changing. A target market is necessary because of different market requirements (see Table 12.2). If targeting the capretto market, for instance, you will want your kids to grow without any setbacks and you will not wean them before sale. Giving grain supplements to kids intended for the capretto market is not a solution because it can cause the meat to darken and toughen. The ideal growth can be achieved fairly simply by:

- selecting the right genetic mix, for example using Boer × dairy and not Boer × angora to achieve maximum growth rate and ease of dehairing for the skin-on market;
- making sure that the does receive peak nutritional levels so that they can cope with the increasing milk demands of their growing kids.

Goats intended for the meat market also need good nutrition – if their protein and energy needs are not met in the paddock they will experience a setback in growth. If there is an energy or protein deficit they will need supplementing with the amounts required to keep them attaining a good daily weight gain. If young growing goats have interrupted periods of growth due to poor feed, they often have difficulty regaining their previous growth rates and frequently do not reach their full potential.

Angora goats are usually discriminated against or even rejected outright, especially in the skin-on market, because they cannot be dehaired; their carcass has also been described as stringy and too fatty. However, angora kids for the capretto market are readily sold in Western Australia where producers sell surplus kids to both the export and domestic trades. Cross-bred Boer × angoras are not usually worthwhile to produce because, in addition to their other problems, they grow slowly compared to other cross-breeds such as Boer × feral or Boer × dairy goats.

Frequently check the current market and its trends. This is true of all agricultural and livestock industries, but it is especially important in the goat meat industry. The goat

Table 12.3 Marketing timetable

When	What	Why
6–9 months before sale	Start checking your markets and keep monthly records of market trends. Keep in touch with goat export companies, butchers and buyers	You see market trends well in advance and can adjust marketing strategies if necessary
4–5 months before sale	Condition score or weigh goats intended for sale	Changes to nutrition can be made to ensure that goats will be in market-ready condition (condition score 2–3) at the time of sale
6 weeks before sale	Drench: only if necessary (do not use off-label drenches). If possible, have a faecal egg count done to decide whether to drench. Use chemicals and injections strictly on an as-needs basis from now until the day of sale	To ensure that there are no chemical residues in the goats in order to comply with the export slaughter interval) and withholding period. The ESI is the minimum time between the last treatment of an animal and its slaughter for export. The WHP is the minimum period between the last treatment of an animal and its slaughter for human consumption in Australia
4–5 weeks before sale	Keep in touch with your buyer or agent	If the market looks shaky it will give you time to find another buyer
4–5 weeks before sale	If not transporting your goats yourself, contact your carrier	Carriers and transport companies have busy periods and it may be necessary to let them know in advance approximately when you will need them
4 weeks before sale	Re-weigh your goats	Adjust nutrition levels if needed
7 days before sale	Re-weigh goats and draft goats for sale into a separate paddock	Avoids a last-minute rush
2 days before sale	Move sale goats to a paddock near the yards and confirm arrangements with your buyer and transport company	As above
1 day before sale	1 Move goats into yards the afternoon before pick-up day. Weigh them and note tag numbers etc. for your records 2 Make sure that they have water and if they are travelling for more than a few hours on the transport, give electrolytes in their water 3 Do not give any feed for at least 12 hours before shipment 4 Mark different categories of goats with a different coloured raddle (dye mark) on the head 5 Prepare your paperwork for the transport driver: waybills, declarations etc.	1 So that they are ready to load when the truck arrives. Weighing them again gives you an idea of expected dressing weights and allows you to check your weights against those on the kill sheet provided by the abattoir 2 Making sure that water is available, especially if it contains added electrolytes, helps to lessen moisture loss during transport and aids in preventing stock losses. Goats can lose up to 20% of their bodyweight due to moisture loss during transport. 3 Processors frown on dealing with animals with full guts as it makes processing more difficult 4 This makes sorting easier and faster for the transport driver and the workers at the other end. Use sheep-marking dyes which wash out, not paint
Day of sale or pick-up	Have everything ready to load the goats at the agreed time	Drivers do not appreciate being kept waiting as they are usually on a tight schedule and may have other pick-ups

industry in Australia is comparatively young; markets are less stable than those of the cattle and sheep industries, which have been established for many years. A market that buys many animals last season may not be buying the next. A good example is the export market to China for live South African Boer goats intended for breeding. In 2003 the market was very good but in 2004 it came almost to a standstill, leaving a number of stud breeders with a lot of breeding stock on their hands.

The main export-marketing period for goat meat in Australia is from June to October when the best prices are obtained by producers; most domestic markets are reasonably steady throughout the year. When arranging transport, use a company that is experienced with goats and their special handling requirements.

When looking for marketing opportunities, ask other producers where they sell their goats and whether the purchasers pay on time and at the agreed price and, if there are any condemned animals, whether feedback is provided on why they were condemned.

Table 12.3 gives a suggested timetable for preparing goats for market.

Goats are usually slaughtered the same day they arrive at the abattoir but may be kept overnight and processed the next day. If so, they will be given water and a very small amount of feed. After the goats are slaughtered, the carcasses will be weighed and inspected and any that have been damaged by bruising etc. in transit may be condemned or the damaged area removed and the rest of the carcass passed after inspection. Other reasons for carcasses being condemned are:

- abscesses – caused by caseous lymphadenitis (CLA, also known as cheesy gland), grass seeds or recent antibiotic injections. Injection abscesses are especially common when penicillin is used. This is why it is always advisable to inject vaccines and antibiotics in the neck area where they are less likely to cause problems during processing;
- Johne's disease;
- condition score 1 or less, seen in starving and drought-stricken animals;
- disease or injuries of various kinds.

The company or cooperative that arranged the slaughter of your goats will send a kill sheet a few days after slaughter. This details the hot dressed carcass weights of the goats and any that were condemned. You also receive details of costs (if any) and what you will be paid for your goats. You are usually asked by the purchasing company if you are registered for GST; if so, the company or buyer will add GST to the payment. It is up to you to arrange to remit this to the ATO in the usual manner.

If any of your goats are condemned, request feedback on the cause of condemnation because you can't fix the problem if you don't know what it is.

It is a long journey from the purchase of your first goats to the satisfaction of receiving a cheque for your first sale. It is a journey filled with good planning, a lot of hard work, a little luck and some pleasure in the final achievement of your goal: the breeding and marketing of good-quality meat goats for the domestic and export markets. We hope that this book's contribution to the industry will help to make the journey a little easier for fellow producers.

Appendix 1
Resources for producers

Government departments

Name	Web and email address	Postal address	Phone/fax	Resource
Austrade	www.austrade.gov.au		Export Hotline: 13 28 78	For trade assistance and business briefings. Austrade has a network of offices around the world that will assist Australian businesses with research, appointments and other services.
Australian Customs Service	http://www.customs.gov.au		Ph: 1300 363 263	Advice on importing and customs declarations.
Australian Government Agricultural Portal	http://www.agriculture.gov.au			An ever-expanding catalogue of federal, state and territory government information and services for the agricultural, fisheries, processed food and forestry industries.
Australian Pesticides & Veterinary Medicines Authority	http://www.apvma.gov.au Email: contact@apvma.gov.au	John Curtin House PO Box E240 Kingston ACT 2604	Ph: (02) 6272 5852 Fax: (02) 6272 4753	The National Registration Authority for Agricultural and Veterinary Chemicals. Allows users of chemicals to search for products by name and brand and download copies of regulations and permits.
Australian Quarantine Inspection Service	http://www.aqis.gov.au	PO Box 858 Canberra ACT 2601	Freecall: 1800 020 504 Ph: (02) 6272 3933 Fax: (02) 672 5753	Export and import conditions for plants and animals. Electronic lodgment of and issue of export documentation and helpful information about the same.
Australian Taxation Office	www.ato.gov.au		Personal direct: 13 2865 Business direct: 13 7226	For all enquiries on taxation and GST.
Bureau of Meteorology	www.bom.gov.au/weather			
Commonwealth Scientific Industrial Research Organisation	www.csiro.au Email: enquiries@csiro.au		General enquiries: 1300 363 400 Fax: (03) 9545 2175	Large organisation that covers numerous fields. The website has links to many very useful sites.
Dept of Primary Industries NSW	http://www.dpi.nsw.gov.au Email: nsw.agriculture@agric.nsw.gov.au	Locked Bag 21 Orange NSW 2800	Ph: (02) 6391 3100 Fax: (02) 6391 3336	Good information on goats and downloadable AgFact sheets on the website. On the homepage, hover on ANIMALS and on the dropdown menu select Goats.
Dept of Primary Industries NSW (feed database)	http://www.agric.nsw.gov.au/feedbase			Brilliant interactive database that lists the nutritional values of everything from apples to sawdust and more. Recommended.

Name	Web and email address	Postal address	Phone/fax	Resource
Dept of Agriculture Fisheries and Forestry	http://www.affa.gov.au	GPO Box 858 Canberra ACT 2601	Ph: (02) 6272 3933 Levies Management Unit Ph: 1800 020 619	Good database. The site includes links to many Australian and international government websites to access information on such things as residue limits and exotic animal diseases.
Dept of Primary Industry and Fisheries NT	www.primaryindustries.nt.gov.au	GPO Box 990 Darwin NT 0801	Fax: (08) 8999 2111 Ph: (08) 8999 2311	Good database for agricultural info and animal husbandry. The site includes info on stock movements and permits etc.
Dept of Primary Industries and Fisheries Qld	www.dpi.qld.gov.au Email: callweb@dpi.qld.gov.au	GPO Box 46 Brisbane Q 4001	DPI& F Call Centre: Ph: 13 25 23	Helpful staff that go out of their way to assist you with your enquiries. Very useful website with many downloadable DPI Fact sheets and useful links to other sites.
Dept of Primary Industries and Resources SA	www.pir.sa.gov.au	PO Box 1671 Adelaide SA 5000	Ph: (08) 8226 0222 Fax: (08) 8226 0476	Useful info for primary producers.
Dept of Primary Industries, Water and Environment Tas.	www.dpiwe.tas.gov.au	Level 2, Marine Board Building 1 Franklin Wharf Hobart Tas. 7000	General Manager, Food Agriculture and Fisheries: Ph: (03) 6233 2581 Fax: (03) 6233 6386	Good website that contains a lot of useful information.
Dept of Natural Resources and Environment Vic.	www.nre.vic.gov.au	PO Box 500 East Melbourne Vic. 3002	NRE Customer Service Centre: Ph: 13 61 86 Fax: (03) 5332 5050	A wealth of information on this site. Very helpful staff.
Dept of Primary Industries Vic.	www.dpi.vic.gov.au			Helpful staff who will assist with any enquiries. Good information and links to other sites.
Dept of Agriculture WA	www.agric.wa.gov.au	Locked Bag No 4 Bentley Delivery Centre WA 6983	Ph: (08) 9368 3333 Fax: (08) 9368 1205	Good links on the website and many useful Farmnotes on goats and agriculture in general to download.
Dept of Natural Resources Qld (weather site called Longpaddock)	www.dnr.qld.gov.au/longpdk			The website deals with weather, drought reports and the latest SOI (Southern Oscillation Index) data and offers helpful advice on permits and dealing with travelling stock in dry conditions. A very useful site.
Drought Response Hotline Vic.	www.dpi.vic.gov.au/drought		Ph:13 61 86	Very useful site and helpful staff at the call centre.
Dry Season Hotline WA:	www.agric.wa.gov.au/ Adverse_season/hotline		Ph:1800 198 231	Very useful site and helpful staff at the call centre

Name	Web and email address	Postal address	Phone/fax	Resource
Export Finance and Insurance Corporation	http://www.efic.gov.au Email: info@efic.gov.au	EFIC has offices in all mainland Australian states	Ph: 1800 685 109 Fax: 1300 654 122	Provides goods and services that help exporters manage the payment and finance risks in exporting.
Government Business Information Service (Smart Licence)	www.statedevelopment.qld.gov.au/start/information		Qld clients: Ph: 1800 061 631 Interstate clients: Ph: (07) 3221 1620	Information about business regulations, licences and state, federal and local government assistance programs.
Meat Industry Authority NSW	www.meat.nsw.gov.au			Includes saleyard statistics.
Queensland Government Statistician's Office	www.statistics.qld.gov.au/stab_frameset.html			
US Dept of Agriculture	http://www.ams.usda.gov/index.html			Interesting information on this site. Be cautious of recommendations for chemicals.
US National Statistics Service	www.usda.gov/nass NASS customer service email: nass@nass.usda.gov	USDA-NASS Room 5829-South Washington DC 20250 USA		Very useful site. Type goats into their search engine. There are hundreds of useful statistics and articles on their website.

Agencies, associations, organisations and others

Name	Web and email	Postal address	Phone/fax	Resource
Animal Health Australia	http://www.aahc.com.au Email: aahc@aahc.com.au	Suite 15 26–28 Napier Close Deakin ACT 2600	Emergency Disease Watch Hotline: 1800 675 888 Ph: (02) 6232 5522 Fax: (02) 6232 5511	A non-profit industry body formed in 1996 in response to the need for policy direction and future planning and funding of national animal health programs. Dealing with all aspects of animal health, such as exotic diseases and disease outbreaks. An excellent informative website, that includes a Johne's Disease Information Centre link.
Arrow Farmquip		PO Box 40 Tamworth NSW 2340	Ph:1800 814 107 or (02) 6762 1956	Manufacturers of goat handlers and equipment. Free advice on yards on request.
Goat Meat Producers Co-operative Ltd (t/a Ausgoat)	Email: dclinker@bigpond.com	Goat Meat Producers Coop Ltd PO Box 46 Wooroolan Qld 4608	Ph: (07) 4164 2223	Producers' co-op with approximately 350 shareholders throughout the eastern states. Largest goat meat producer group in Australia. Exports to many overseas countries.
Australian Alpaca Association	www.alpaca.asn.au		Ph: (03) 9873 7700	Useful website. Members of association very helpful with info about alpacas.
Australian Cashmere Growers Association Ltd		PO Box 380 Kellyville NSW 2155	Ph: (02) 9894 7877 Fax: (02) 9894 7055	Market information and cashmere fleece sales.
Australian Meat Council	www.amc.asn.au	23 Hunter St Sydney NSW 2000	Ph: (02) 9233 1433 Fax: (02) 933 1443	Good links and information.
National Association for Crop Production & Animal Health	www.avcare.org.au			Much information on agricultural and veterinary chemicals. Links to other sites of interest.
Boer Goat Breeders Association of Australia	http://boergoat.une.edu.au Email: boergoat@abri.une.edu.au	BGBAA c/- ABRI University of New England Armidale NSW 2351	Ph: (02) 6773 5177	The official BGBAA website has info on registered Boer goats and breeders. The website also lists many useful links. The BGBAA at ABRI controls the national registry of Boer goats.
CRC: Weed Management	www.weeds.crc.org.au Email: crcweeds@waite.adelaide.edu.au	CRC for Australian Weed Management University of Adelaide PMB 1, Waite Campus Glen Osmond SA 5064	Ph: (08) 8303 6590 Fax: (08) 8303 6590	A useful website and helpful staff. Many useful links to sites both in Australia and overseas.

Name	Web and email	Postal address	Phone/fax	Resource
Farmers Mailbox	www.fmb.com.au Email: Info@fmb.com.au	PO Box 506 Emerald Vic. 3782	Ph: 1800 816 699 or (03) 5968 6210 Fax: (03) 5968 6209	Mail orders Australia-wide for goat tags, tattooing supplies and other equipment.
Farmonline website	www.farmonline.com.au			Rural press site that provides links to many newspapers and journals.
Gasparotto, Suzanne Onion Creek Ranch Home of the Tennessee Meat Goat	www.tennesseemeatgoats.com Email: onioncrk@centex.net	Suzanne Gasparotto HC 70, Box 70 Lohn TX 76852 USA		Website has a lot of very useful information and is well worth a visit. Suzanne has written on goat husbandry and related subjects for many years. Onion Creek developed the Tennessee Meat goat.
Global Agribusiness Information Network	www.fintrac.com/gain			Good agricultural statistics database.
Goat Industry Council of Australia		PO Box E10 Kingston ACT 2604	Ph: (02) 6273 3855 Fax: (02) 6273 331	An industry body helpful on all matters concerning goats.
Kerridale International Trading Pty Ltd	www.kerridale.com.au Email: sales@kerridale.com.au	Suite B, 42 Bryants Road Loganholme Qld 4129	Ph: (07) 3806 5588 Fax:07 3806 5599	Processing goats in South Australia and Queensland for all major export markets.
Pygmy goats	www.kinne.net			Useful information on goats.
Landmark (an AWB company)	www.landmark.com.au Email: webmaster@landmark.com.au	Landmark 380 Latrobe St Melbourne Vic. 3000 Landmark Livestock Dept GPO Box 4562 Melbourne Vic. 3001	Ph: (03) 3842 7733	Landmark is Australia's largest supplier of agribusiness products and services with 430 outlets throughout Australia and is one of the largest sellers and suppliers of livestock in Australia. Landmark supplies both buyers and sellers with comprehensive marketing options. Its website has up-to-date info on livestock sales and other useful information in current issues of Stock Around the Clock.
Livecorp: Australian Livestock Export Corporation	www.livecorp.com.au			Livecorp is an industry body, funded by voluntary contributions from livestock exporters. A wealth of information on live export on its website. Well worth a visit.
Metalcorp Manufacturing	Email: carinya@bluepin.net.au	6 Ampol St PO Box 1256 Armidale NSW 2350	Ph: (02) 6771 1500 Fax: (02) 6771 1363	Manufacturers of a goat handler. Extra modules can be added as needed. Local distributors in most areas.
National Farmers Federation	www.nff.org.au			Links to many agricultural sites

Name	Web and email	Postal address	Phone/fax	Resource
NSW Farmers Federation	www.nswfarmers.org.au			Useful site, worth a visit
Ruralnet website	www.ruralnet.com.au			Index of Australian Agricultural sites. A useful resource.
SAMEX (South Australian Meat Company)	www.samex.com.au/goat			The leading processor & exporter of goat meat in Australia, since 1983
Veterinary Education and Information Network	http://vein.library.usyd.edu.au			This excellent site belongs to the University of Sydney and is a great on-line resource. Good search engine for such things as clinical signs, plant poisoning, epidemiology and so on.
Western Australian Farmers Federation	www.waff.org.au			Useful site. Worth a visit

Books, CDs and videos

Resource	Supplier	Comment
Book: *Blowflies and lice information manual*	Dept of Primary Industries & Fisheries Bookshop Ph: call centre 13 25 23	Targeted to the sheep industry but contains useful information for goat producers.
Book: *The chevon guide*	Meat & Livestock Australia www.mla.com.au Ph: (02) 9463 9333	A book of recipes Intended for the restaurant and retail trades and consumers. Recipes, menus and cooking tips.
Video: *How to get the most from your electric fencing* (duration 58 mins)	Rural Bookshop PO Box 586 Cleveland Qld 4163 Ph: 1800 656 028	Contains good information and instructions on setting up an electric fencing system.
Book: *The diagnosis of the diseases of goats* by S.A. Baxendell (T.G. Hungerford Vade Mecum Series for Domestic Animals (Differential Diagnosis), series B, number 9	University of Sydney Post-graduate Committee in Veterinary Science	A very useful book that helps in the diagnosis of illness in goats using the symptoms as a guide.
Book: *Feeding standards for Australian livestock: Ruminants.* Standing Committee on Agriculture and Resource Management – Ruminants Subcommittee	CSIRO Publishing PO Box 1139 Collingwood Vic. 3066 www.publish.csiro.au/	Useful information on various feed requirements and the effects of temperature etc.
Book: *Goat farming: profitable and productive*	Meat & Livestock Australia www.mla.com.au Ph: (02) 9463 9333	Goat meat production and marketing.
CD: Grazfeed (software program)	Horizon Agriculture PO Box 598 Roseville NSW 2069 Fax: (02) 9440 8011 Ph: (02) 9440 8088	Grazfeed is an easy-to-use computer program that provides a simple way to calculate the energy and protein requirements of sheep and cattle grazing a particular pasture. Runs on any computer using Windows™.
Book: *Growth in the goatmeat industry: is it sustainable?*	Meat & Livestock Australia www.mla.com.au Ph: (02) 9463 9333	Explores global goat meat production and trading patterns, consumption trends, product and market characteristics, opportunities for market expansion and factors that will affect supply and demand over the short and long term.
Book: *The indispensable goat: Queensland pioneers and their goats* by E.A. Beutel and F. Schutt	Dept of Primary Industries & Fisheries Bookshop Ph: call centre 13 25 23	Hundreds of people from every corner of Queensland remember the goats of their childhood with undying love.

Resource	Supplier	Comment
Book: *Organics, opportunities and options: sheep meat and wool*	Dept of Primary Industries & Fisheries Bookshop Ph: call centre 13 25 23	Lists the organic industry contacts needed when converting to organic sheep meat and wool. Could be useful to goat producers.
Book: *Poisonous plants: a field guide* by R.M. Dowling and R.A. McKenzie	Out of print. Try your local library.	An excellent and useful guide to plants poisonous to livestock. Well illustrated.
Book: *Raising goats for cashmere and mohair*	Dept of Primary Industries & Fisheries Bookshop Ph: call centre 13 25 23	Contains practical easy-to-follow advice on all aspects of caring for goats.
Book: *The role of Boer goat crosses in the development of the Australian goat meat Industry* by P. Murray	Meat & Livestock Australia www.mla.com.au Ph: (02) 9463 9333	Research on Boer goats, initiated in mid 1996.
Book: *Toxic plants and animals: a guide for Australia*	Queensland Museum, Brisbane, Queensland	A very useful book with many illustrations.
Book: *Weed control using goats* by Cameron Allan, Peter Holst and Malcolm Campbell	Meat & Livestock Australia www.mla.com.au Ph: (02) 9463 9333	Contains a lot of information including lists of weeds, trees and shrubs palatable to goats.
Book: *Wormbuster*	Dept of Primary Industries & Fisheries Bookshop Ph: call centre 13 25 23	Wormbuster is a program for the effective control of roundworms in sheep. The program works well for goats, but most drenches listed in the book are not registered for goats.
CD: Feedmania™ (software program)	Saltbush Agricultural Software ABRI University of New England Armidale NSW 2351 Ph: (02) 6773 3310 Fax: (02) 6773 3950	Feedmania™ is a diet formulation program. It is available in versions for feed merchants or producers.

Glossary

abomasum: The fourth chamber of the stomach, where true digestion occurs.

abort: To miscarry a foetus before it is capable of surviving outside the uterus.

acidosis (also known as grain poisoning): A-life threatening condition where the rumen becomes too acid. The usual cause is feeding too much grain to animals unaccustomed to it.

acral: Pertaining to the limbs or extremities.

adjuvants: Aluminium derivatives added to killed vaccines to generate more of an immune response than the vaccine alone would.

aflatoxin: A fungal toxin produced by the fungi *Aspergillus flavus* and *Aspergillus parasiticus.*

AI: Artificial insemination – impregnation of a doe with semen harvested from a buck. The semen can be freshly collected or thawed semen from frozen straws. Straws can be frozen in nitrogen and remain viable for many years.

albumin: A small protein in blood that acts like a sponge, to keep fluid within the blood vessels. When it is low, fluid leaks out of the blood vessels and causes oedema.

alopecia: Baldness.

anhydraemia: Decrease in the concentration of red blood cells.

anoestrus cycle: The period of sexual inactivity between fertile cycles.

anthelmintic: Drench for internal parasites.

antigen: A substance that, when injected into an animal's tissues, stimulates the production of antibodies.

anuria: Arrest of urinary output.

ataxia: Loss of coordination, i.e. uneven gait or staggering.

bilirubin: A red bile pigment.

biliverdin: A green bile pigment.

birth canal: Vagina.

blepharospasm: Excessive winking, i.e. spasm of the orbicularis oculi muscle.

bloat: A potentially life-threatening condition where gas is trapped in the rumen.

body condition score: Also known as the fat score, measured rom very lean = 1 to fat = 5. Buyers discriminate against condition 5 goats.

breech birth: A birth in which the kid's posterior is presented, instead of its head.

breeding potential: Ability to produce offspring.

browse: Woody shrubs, weeds and trees; to graze.

brucellosis: Infection with a *Brucella* group bacteria that may cause abortion in livestock. Brucellosis, also known as undulant fever and Malta fever, is a zoonotic disease that causes illness in humans.

burdizzo: An instrument used to castrate bucks by crushing the spermatic cord without breaking the skin of the scrotum.

capretto: Goat meat from young milk-fed kids.

cc: cubic centimetre, the same as mL, i.e. 5 cc = 5 mL.

certificate of service: A certificate or letter provided to the owner of a doe that has been serviced by a buck owned by another breeder. It states all relevant details of the mating such as the names and addresses of the owners, date of mating and mode (i.e. paddock). Full-blood South African Boer kids cannot be registered without this certificate or letter.

chevon: Goat meat

colostrum: The rich first milk produced by a lactating doe. Colostrum contains immunoglobulins (antibodies), high protein and fat levels and other essentials for the kid's health.

conformation: The structural traits of an animal.

controlled mating: Mating selected animals under controlled conditions. Used more often in the horse racing industry.

cross-breed (× breed): A hybrid animal produced by mating goats of two or more breeds, e.g.the kids resulting from the joining of a South African Boer sire mated to an Anglo-Nubian doe.

CRV: Caprine retrovirus, thought to be mainly transmitted through the dam's colostrum and milk. The disease was formerly known as CAE (caprine arthritic encephalitis).

cull: To discard animals that are below standard, too old, surplus to requirements or diseased; an animal that has been culled.

cyanosis: Bluish discolouration of the skin and membranes.

dehydrate: To lose body fluid due to fever, heat or lack of adequate water.

disbud: To remove the hornbuds from kids. Dairy goats are disbudded to make it easier to put them into a headbail for milking. Meat goats are not usually disbudded.

doe: Female goat.

doeling: Young female goat.

drench: A medication administered by mouth (orally); to administer such a medication.

dysentery: Bloody diarrhoea.

dysphagia: Difficulty in swallowing.

dyspnoea: Difficult or laboured breathing.

dystonia: Disorder of muscle tonicity, often seen as painful muscle cramps.

edentulous: Toothless, often seen in premature births and aged animals.

EDOK: Estimated date of kidding, approximately 150 days from the date of joining.

elastrate: To castrate male kids using strong rubber rings made for the purpose. These are applied using an elastrator.

elastrator: The instrument used to apply elastration rings (also known as marking rings).

EMD: Eye-muscle depth.

entropian: A heritable trait where the eyelids (usually the lower) are inverted and rub against the eyes, sometimes causing severe irritation.

ET: Embryo transplant.

external parasite: Any one of many parasites that live in the ear canal or nasal passages, or on the skin or hair of an animal, e.g. ticks, lice and mites.

feedlot: A place where goats are intensively managed and fed to achieve maximum weight gain and/or correct fat scores prior to slaughter or shipment.

flushing: The practice of increasing a doe's level of nutrition prior to joining, with the aim of increasing bodyweight and ovulation rate.

foetal membranes: The placenta and amniotic sac etc. are also known as the afterbirth. The foetal membranes sustain the kid before birth and attach it to the uterus. They are normally expelled within a few hours of the doe giving birth.

foetus: The unborn mammal in its latter stages of in utero development.

forage: Fibre-containing feed, such as hay and pasture.

forcing pen: Pen used to confine goats before they are moved into the handling chute or crush.

genetic correlation: The relationship between two traits that are influenced by a common set of genes.

gestation period: The period from conception to birth.

glucosuria: Sugar in the urine.

grain-assisted: A term used for stock that are supplemented with grain in addition to grazing, but are not intensively managed in a feedlot.

haemochezia: Passing of red blood cells in stools.

haemoconcentration: Increase in the concentration of red blood cells.

helminths: Parasitic worms.

husbandry: The management and care of animals.

hyperaesthesia: Abnormal sensitivity of the skin or organ.

hyperemesis: Excessive vomiting.

hypocalcaemia: Low levels of calcium in the blood.

hypoglycaemia: Low levels of glucose in the blood.

hypomagnesaemia: Low levels of magnesium in the blood.

hypoprogesteronism: A condition where the corpus luteum fails to produce enough progesterone to sustain pregnancy: this condition is one of many causes of abortion.

hypothermia: The inability to maintain body heat. It can be due to chilling from cold and wet weather, premature birth or disease.

icterus: Jaundice, due to increased amounts of bile pigments in the blood.

immune: Resistant to a particular disease-causing pathogen.

immunoglobulins: Antibodies.

in utero: In the uterus, i.e. before birth.

intubate: To place a tube down the oesophagus into the stomach to administer milk, water or other fluids.

isolate: To quarantine new, diseased or injured stock for observation and/or treatment.

join: To mate male and female livestock.

kid: Young goat.

kidnap: When a doe steals another doe's kid.

legume: Plants of the pea family, usually bearing seeds in a pod, e.g. lucerne.

leukocyte (also leucocyte): White blood cell.

liveweight: The weight of an animal that has been fasted (usually overnight) prior to slaughter.

lochia: The reddish- to chocolate-coloured post-kidding discharge from does several days after giving birth.

luxation: Dislocation.

maremma: An ancient breed of Italian dogs used to guard herds and flocks.

mark: To castrate a male goat.

melaena: The passing of dark or black-coloured stools.

metabolic disease: A disease caused by an abnormal metabolic process. It can be genetic or acquired, e.g. liver failure, or it may be caused by an imbalance of minerals such as calcium or magnesium.

mismothering: The rejection of kids by their dam.

monogastric: Having a single-chambered stomach, e.g. humans and horses.

muster: To gather or round up the herd.

natural mating: Directly mating a buck and doe without the use of artificial insemination or embryo transplant.

necrosis: The death of tissue or cells from disease or accident.

nystagmus: Oscillatory movements of the eyeballs.

oedema: An effusion of serous fluid into the interstices of cells in tissue spaces or into the body cavities.

oestrogen: The hormone that cause the regression of the corpus luteum and precipitates the oestrus cycle.

oestrus cycle: Fertile cycle, also known as the heat cycle or 'season'.

omasum: The third chamber of the stomach.

opisthotonus: Tetanic spasm in which the animal extends and stiffens, with a tendency to raise and extend the head, stiffen the tail, bow the back and loins down, and stiffen and project the abdomen.

paddock mating: Natural mating in the field and not in controlled conditions.

parenchyma: The proper tissue of an organ as distinguished from its connective tissue.

parturition: Birth.

petechia: Pinpoint spots of haemorrhage on the skin, serous membrane or mucous membrane or on the surface or cross-sectional surface of an organ. Often seen throughout the intestines and other internal organs after aflatoxin poisoning.

placenta: An organ formed on the wall of the uterus which, joined to the kid by the umbilical cord, nourishes and sustains the kid in utero.

Post-natal: Period after birth.

prepuce: Penile sheath.

progeny: Offspring.

protein supplement: A high-protein feed fed to animals to increase their protein intake, e.g. defatted soy meal.

protein: Nitrogen-based chain of amino acids present in all living things.

pruritis: Itching.

quarantine: To keep new, injured or sick stock apart from other animals for observation and/or treatment.

ration: The feedstuff fed to an animal in any 24-hour period.

rehydrate: To replace body fluids lost due to transport, illness or heat.

retained placenta: Placenta fails to be expelled after the doe gives birth.

reticulum: Second chamber of the stomach.

rising plane of nutrition: An increasing level of feed, usually in response to the higher nutritional requirements of pregnant or lactating does.

rumen: The first chamber of the stomach, where the digestive process begins.

ruminal scratch: Roughage, e.g. hay.

ruminant: Any animal with a multi-chambered stomach such as a cow, sheep or goat (four chambers) or an alpaca (three chambers).

ruminate: Regurgitate cud for further chewing.

scours: A type of diarrhoea usually caused by incorrect feeding.

scrotum/scrotal sac: A pouch that contains the testicles in which sperm are produced.

service: Mate.

sire: To father; the father.

tachycardia: Uneven heartbeat.

teat: Nipple.

tenesmus: An urgent desire to urinate or defecate, without the ability to do so.

testicles: Produce sperm and are contained in the scrotum. Usually there are two but rarely a buck may have only one in the scrotum; the other may be undescended and remain in the abdominal cavity.

urinary calculi: Stones in the urinary tract, caused by a dietary imbalance in the calcium:phosphorus ratio. The usual recommendation is 2:1 (calcium:phosphorus).

uterus: Womb.

vaccine: A suspension of attenuated or killed microorganisms (bacteria, viruses or rickettsiae) administered to prevent, ameliorate or treat an infectious disease.

vulva: Exterior opening of the vagina.

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